POWER

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# The Outlook for the Power Plant Engineer

THE FACT that electricity may be had on tap like water or gas has resulted in the failure of many factories and other establishments to install and operate power plants of their own.

Not only are many new establishments running on purchased current, but many old ones have shut down their plants and take their power "from the street." This has made an inroad in the *number* of opportunities available to power plant engineers.

Men who have spent their lives in the operation of particular power plants find themselves out of positions, not always or usually through any fault of their own. Economy of operation is not the only consideration that enters into the decision to abandon a plant. They are the victims of modern methods, of changing practice.

But, if the best figures I can procure are reliable, there is fully four times as much power-generating capacity requiring the services of operating engineers in this country today as there was at the beginning of the century. While a large proportion of this is in utilities, that in private industrial plants is twice the 1900 figure and practically the same as 1919. This is exclusive of the large number of plants still installed in hotels, department stores, office buildings, and other industrial establishments not included in the census.

Although the total capacities of such private plants has remained nearly constant for the past ten years, their number has been nearly halved and their average size practically doubled. This is in line with the survival of the bigger and better plants.

Electricity is not a prime mover. Behind every motor there is a generator and behind every generator a turbine or engine of some sort requiring engineers to operate it. The central station has furnished some of the most responsible, remunerative, and attractive positions in the field. The modern industrial plant with its complication and multiplicity of services offers opportunities for the best that the power plant engineer has to offer in talent, ingenuity, education, and experience.

It would be interesting to know how the number of engineers now employed in power plants and how much money is paid to them in salaries and wages compares with the beginning of the century or with ten years ago.

There may be fewer jobs than there would have been without purchased power, but there are more worth-while positions. Centralization has not robbed power plant engineering of its opportunities.

F. R. Low

# EDITORIALS

## Let Quality, Not Quantity, Be the Guide

NOW IS the time when committees are at work formulating programs for society meetings during the coming fall and winter. The urge for complete coverage often results in programs unwarranted by development in the field. Therefore, it would be well for such committees to heed the feeling, prevalent among many engineers, that there are too many meetings and too many mediocre papers.

The demands upon an engineer's time are exacting, and he is justified in expecting that the time spent in attendance will be rewarded by the knowledge gained. Disappointment in this respect incurs unfavorable reaction and lack of interest in subsequent meetings.

It has been said that the besetting sin of Americans is to overstress "bigness." As applied to engineering conferences, other countries are not free of this indictment. It is well to remember that attendance and the number of papers are not necessarily a measure of the contribution to engineering thought and progress.

It is increasingly apparent that programs will have to be kept in line with the needs as dictated by advances in the field, even though this results in fewer meetings and fewer papers.

## Boiler Room Luxury In August

NOT MERELY TOLERABLE, but downright comfortable. Believe it or not, this describes a boiler room at noon of a hot August day. A member of the *Power* staff looking over a new plant was the beneficiary of this unexpected experience.

The explanation, as far as he could see, lay in the following factors. First, the boiler room was well isolated on ground where every breath of wind had free play. Large curtain doors at each end were wide open, permitting a steady flow of air from one end of the plant to the other. A high boiler room with ample space around the boilers helped this movement. Plenty of light came in diagonally through the walls, largely glass, but the gypsum block roof resisted the direct penetration of the sun's rays.

Finally, the boiler settings themselves were air and water cooled, and all steam drums and lines, including flanges, were well insulated.

It may be that the aluminum paint liberally applied to all insulated surfaces, as well as exposed steel work, added but little to the actual heat-insulating effect, but the psychological result was important. The boiler room looked cool. It was certainly clean. Half of the mental and physical discomfort of a hot plant comes from the dirt that is allowed to accumulate.

Refrigerated drinking water and hot and cold showers gave a final touch. Alertness and complete satisfaction were mirrored on the faces of the plant staff.

## The Internationalism of Prosperity

DESPITE all that has been said and written about it, the world over, there remains a surprising lethargy or indifference among many with respect to the fundamental relation between prosperity and internationalism.

There seems to be the feeling among some that other countries may have their ups and downs but the United States goes on forever, or at least that the United States will find, quite within its own borders, the panacea for its business ailments, past, present, and future. The past seven or eight years of good business has been blindly accepted as evidence that it is unnecessary to take an interest in the international markets.

It is not unusual for some concerns to neglect their export markets in times of prosperity and healthy demand for their products at home. Their chief concern has been only to see that the home market was not disturbed by outsiders. Only when the home market ceases to absorb the full factory output do they turn to the export field for relief.

When it is found that cheaper production costs by competitive countries or lack of buying capacity has virtually shut off exports, a policy of curtailment is

inaugurated that brings unemployment and distress. This, in turn, leads to loss of confidence at home and the cumulative chain is put into motion.

With comparatively few exceptions, the industrial countries of Europe are already in a dominating position in the foreign markets. They are consolidating their positions during the present period of general dullness. They are equipping old factories with new machinery to reduce costs. They are "rationalizing," as it is called.

Plants long since amortized are being swept bodily from the line of battle. Industries, be they exporters or otherwise, must heed these signs if they wish to secure their share of the world's business or continue to enjoy a good market at home.

It is equally true that these international influences will have their effect upon the prices in our home market as well as abroad, for, as they limit our factory production, they bring about unemployment and decrease local buying power.

It follows directly that industry must find ways to decrease the cost of its products for home consumption as well as for export. Those concerns which recognize this and take advantage of the present lull to put their houses in order by eliminating waste, redesigning processes of manufacture and replacing obsolete equipment will get the business. Industry in other countries is doing just this.

## The Foreign Machinery Complex

RECENTLY our living ex-President, in one of his daily press comments, inferred that foreign aviation engines are superior to domestic ones, quoting a naval officer to that effect.

This is but an example of a current opinion that the imported article is always superior, whether it be cheap perfume, silks or engines, which has existed ever since the adventurer returned from the Far East with his cargo of spices, ivory, and jewels.

A discussion of the relative merits of foreign vs. domestic dress goods is outside *Power's* sphere. But what are the facts concerning machinery?

The aviation engine, so criticized by the naval officer, has seen its greatest development in America; no foreign builder can show such performance records as have become usual for the domestic product. Metallurgical advances have been incorporated in the design, while workmanship is equal, and in fact superior, to the average imported engine. This should not be surprising, for the American builder has adopted the machine precision method of manufacture in preference to the numerous European hand-tooling processes.

This same attitude as to other types of internal-combustion engines is deep-rooted in the average man's mind. Corporations wishing to engage in Diesel building obtain foreign licenses instead of employing an American designer. Invariably the foreign design must be so revised to meet American conditions that it loses its imported characteristics.

The American designed or the redesigned foreign Diesel is able to burn a cheaper oil than a foreign-built engine. Yet, an American university has seen fit to import two Diesel engines, even though these engines are forced to use a fuel oil costing fifty per cent more than the oils used in most American Diesels of the same size.

This fascination for foreign ideas is difficult to understand in view of the fact that the most successful engines in this country are the product of American designers.

## Save City Water and Decrease Operating Cost

THE POWER plant of a hotel has many services to perform other than supplying electrical energy. Steam is required for heating and cooking, hot and cold water for laundry washing and guests, and refrigeration for air conditioning and food preservation. Two major raw materials, fuel and water, are used in the performance of these services.

It is true of most power plants, and also of the hotel plant, that the greatest effort to decrease operating cost is directed toward a reduction of fuel consumption. This is natural, because it represents the largest single operating cost, and because if it is not continually watched fuel is easily wasted.

In the hotel plant water supply generally is taken from the city water mains and must be paid for. Its cost forms a considerable part of the raw material cost, in some cases amounting to about half the expenditure for fuel.

All too frequently little effort is made to conserve the consumption of water, although much can be done in this direction in the original plant design or by later changes in piping that permit of using water over again for several purposes before it is wasted to the sewer. The operating engineer can do much to conserve water by decreasing the boiler feed make-up requirements, stopping leaks, and regulating the flow of cooling water to refrigerating and other machines.

When water is purchased its conservation should not be neglected in any effort to decrease plant operating costs.

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**POWER *Stands for . .***

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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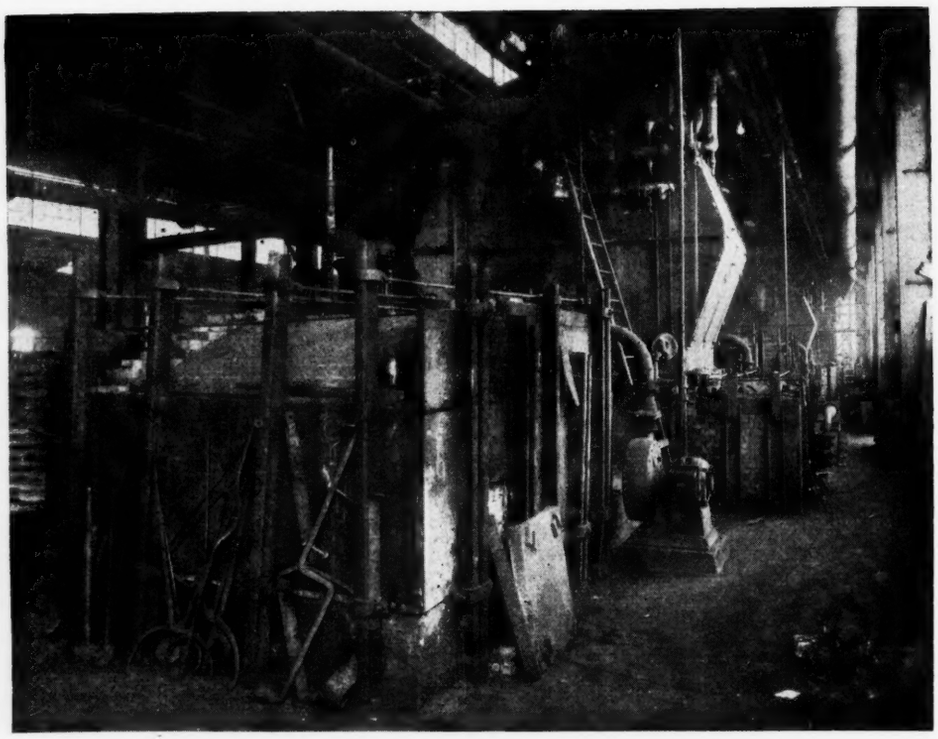

Typical waste-heat boiler and stock-furnace unit with top of hammer in background

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# Mixed-Pressure Turbines Insure Attractive Savings

**Hot gases from the stock heating furnaces make steam for the hammers. Exhaust steam from the hammers generates the electrical load in mixed-pressure turbines**

UTILIZATION of only a portion of the waste heat available in the shop of the Kropp Forge Company of Chicago has resulted in large savings in fuel and power costs. Beginning with the use of the waste gases from the stock heating furnaces for generating steam for the hammers, the company eventually decided to install mixed-pressure turbines to recover from the exhaust of the hammers the remaining heat available in the form of electrical energy. Owing to the number of hammers, steam in abundance and continuous supply is available to generate the entire electrical load and thus replace purchased service except for night lighting. When anticipated extensions to the forge shop, including electric furnaces for annealing the forgings and another large crane, have been made, the net savings in operating expense from the latter step in heat recovery will approximate $20,000 a year.

Before proceding with the story something about the company and the present forge shop equipment should be known. For more than 28 years the present organization has been engaged in the manufacture of forged-steel products, including flanges, of which an exceedingly large stock is carried. Today the plant is equipped to rough turn, hollow bore, finish complete, and also heat treat all kinds of steel. Complete stocks of standard dies for both hammered and drop forgings are available. Hammered forgings weighing from 1 lb. to 15 tons and drop forgings ranging from 1 oz. to 700 lb. are produced.

The shop is equipped with twenty-two hammers, twenty using steam and two being driven by motor. Each of the large hammers is provided with a service unit consisting of two oil-fired furnaces to heat up the stock, located one on either side of a 1,500-sq.ft. waste-heat water-tube boiler that supplies the steam to the hammer. Waste gases from these furnaces give up their heat to the boiler, and supplementary heat is supplied by two oil burners set in a Dutch oven in front of the boiler. A motor-driven fan supplies the blast for the furnaces and air under pressure to atomize the oil.

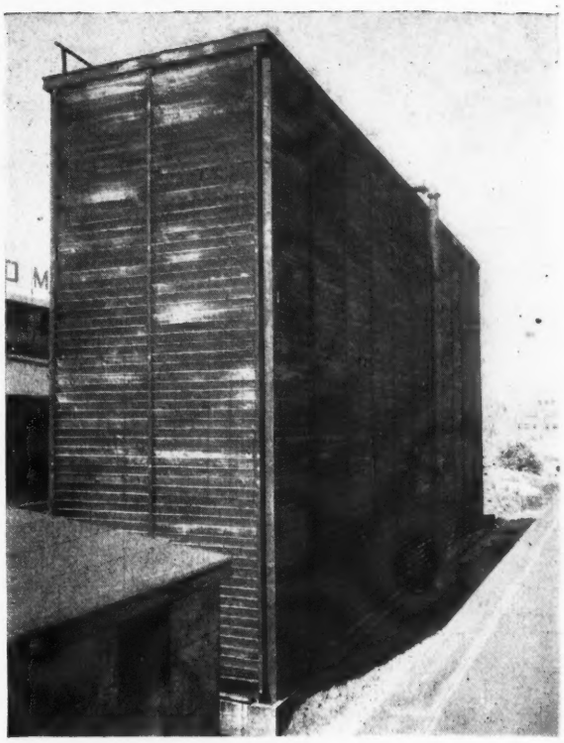
Eight of the hammers had been connected to a common exhaust main to supply heat for the buildings and for the boiler feed water. Calculations preliminary to the turbine installation showed that under normal operation exhaust steam from these eight hammers would average over 34,000 lb. per hour. Under a guaranteed water rate of 38 lb. per kilowatt-hour, this quantity of steam is sufficient to generate 900 kw., and if at any time more steam should be needed, the exhaust from the remaining steam hammers in the shop can be connected into the system.

With the shop extension temporarily delayed, the present normal load for the 10 hr. of day operation averages about 180 kw., with peaks running from 300 to 320 kw., and totals 1,800 kw.-hr. A proposed shop extension will increase the load about 150 per cent, bringing up the average to 450 kw., with peak loads probably in the vicinity of 700 kilowatts.

Naturally, the plant was designed for the latter conditions, so two mixed-pressure turbines of 500 and 300 kw. capacity were installed, with the possibility of a third unit at a future date. An existing brick building adjacent to the forge shop was used for the power plant.

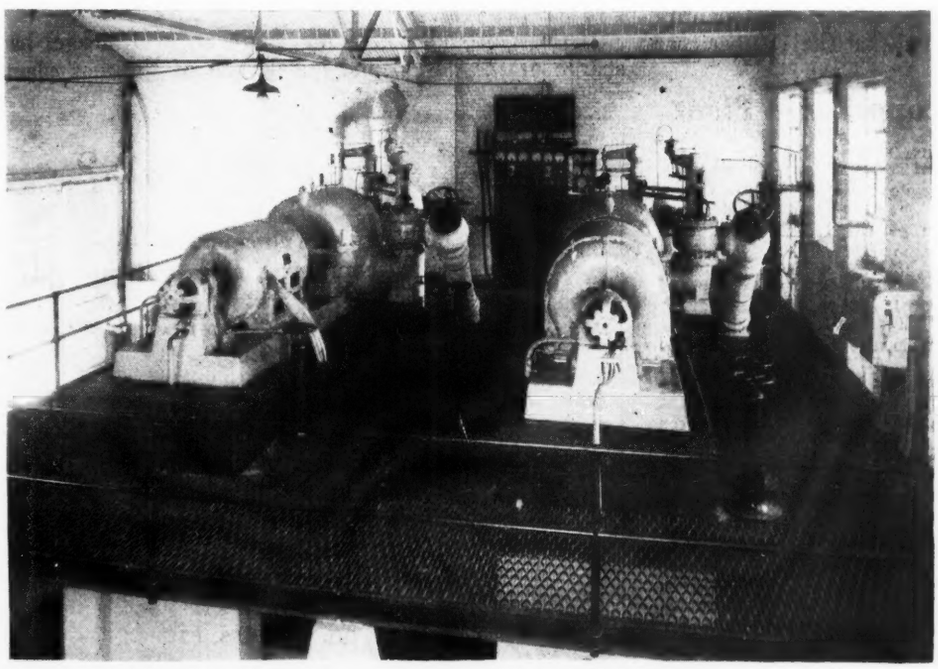
An accompanying photograph shows the two machines, each consisting of a 3,600-r.p.m. mixed-pressure turbine, a 3-phase, 60-cycle, 240-volt generator and a direct-connected exciter at the end of the shaft. Multi-jet condensers give a vacuum of 27 in. Circulating water comes from the city mains, but the supply is conserved by a cooling tower of atmospheric type, rising 34 ft. above grade, with a 22,000-gal. concrete collecting basin below. It is surrounded by wooden louvers. Troughs across the top distribute the water, and interior baffle construction breaks it up. Rated capacity is 1,500 gal. per minute, with a temperature drop of 10 to 15 deg. between incoming and outgoing water.

Two circulating pumps driven by a single motor serve each condenser. One of these pumps draws the water from the cooling tower basin and forces it into the condenser. Discharge from the condenser is into a short piece of 24-in. pipe closed at the bottom, which overflows into a concrete basin. The second pump, which has about 3 per cent greater capacity, draws the water from the basin and forces it to the top of the cooling tower. Owing to its greater capacity there would be a tendency to exhaust the basin, so a float valve has been connected to the discharge, allowing water in sufficient quantity to flow back into the hot well to maintain a constant level.



**The atmospheric cooling tower rises 34 ft. above grade**

Exhaust steam from the hammers comes to the turbines at a pressure fluctuating between 3 lb. gage and 5 in. vacuum. A 14-in. receiver-type separator in the line has been effective in removing oil and packing from the hammer cylinders. At the lower limit the turbine governors automatically change over to operation on high-pressure steam, which in ordinary service ranges from 80 to 120 lb. When the pressure in the exhaust main rises to atmospheric, low-pressure operation is resumed. A safety-valve between the high- and low-



**The mixed-pressure turbines take steam from the hammers**

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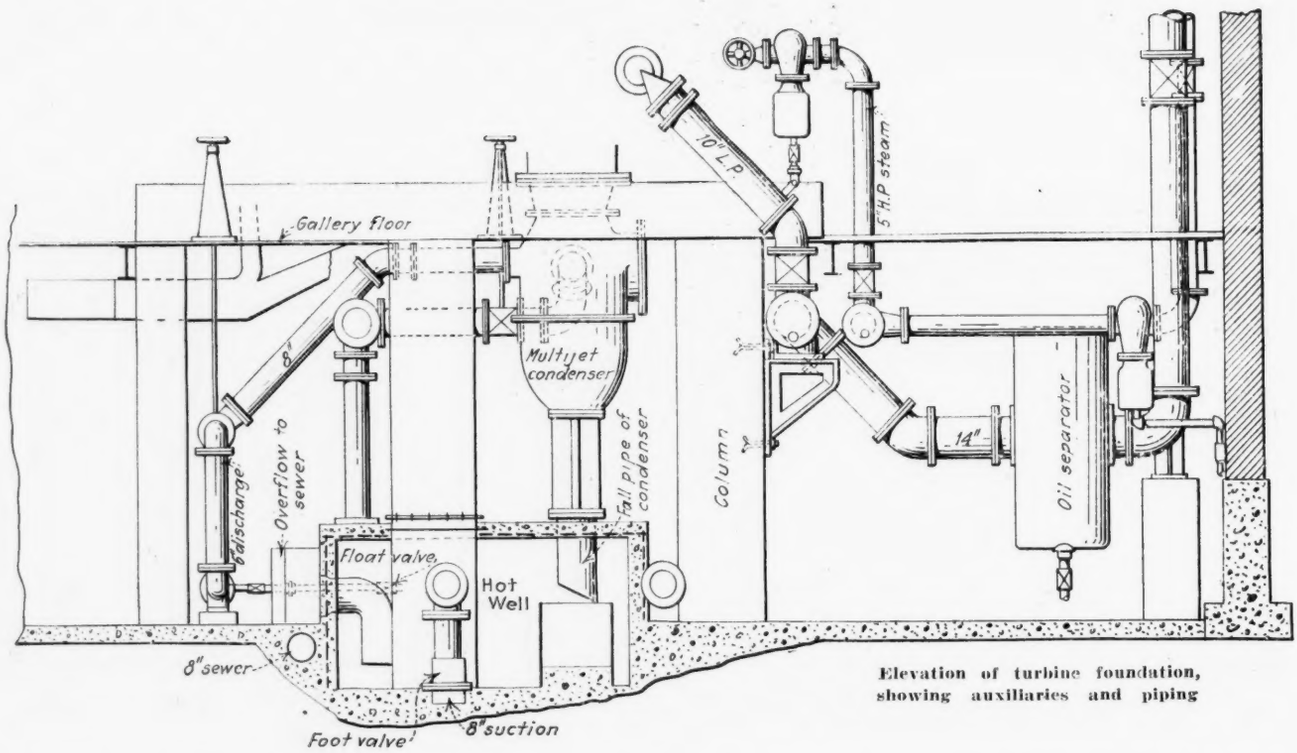



**Elevation of turbine foundation, showing auxiliaries and piping**

pressure headers is provided to prevent waste of boiler steam. It is set to pop at a pressure 8 lb. lower than the safety valves on the boilers, so that any surplus is blown into the exhaust main to be used in the turbines.

On April 12 the plant went into service. As it is practically automatic little attention other than for starting or shutting down is required.

As to the saving in the operating expense, certain estimates have been made that will give an approximation of the possibilities. It will be recalled that the power plant building was available. As a result of using the waste heat in the gases and in the exhaust steam there is no fuel expense. No additional labor was added, but the chief engineer gives the plant part of his time. The investment in equipment totaled $60,000.

Some months ago when the shop was running normally, the power bill approximated $11,000 per year. Taking into account the reduction in rate with quantity consumption, it has been estimated that the 150 per cent increase in load from the shop extension would double the annual current bill, making it $22,000. Supplies and maintenance for the new plant have been placed at $600 per year, and an allowance of $1,400 made for part of the engineer's time. Eliminating the purchase of current would thus effect a saving of $20,000 per year.

Also interesting is the fact that the ready-to-serve charge on the anticipated load would approximate $650 per month, or $7,800 per year. The usual 12 per cent overhead charge on the $60,000 investment totals $7,200 per year. With the shop shut down or running light, it is easier to charge off this overhead than to actually pay the $7,800.

In the foregoing estimate of savings, overhead has not been considered. A charge of 12 per cent on $60,000 would amount annually to $7,200 and would reduce the net saving or profit over former operation to about $13,000 per year.

C. M. Garland, consulting engineer, of Chicago, had charge of the design and installation of the new plant.

## New Equipment in Kropp Forge Plant

Turbine, one 500-kw., mixed-pressure, 125 lb., g., or 17 lb., abs. ..... Terry Steam Turbine Co.
Generator, one, 500-kw., 3-phase, 60-cycle, 240-volt, 3,600-r.p.m., ..... Allis-Chalmers Mfg. Co.
Condenser, multijet, 15,000 lb. steam per hr., 1,500 g.p.m. condensing water, 27 in. vac. ..... Schutte & Koerting Co.
Circulating pumps, two, 1,500-g.p.m., 35- and 45-ft. hd.; driven by one 40-hp. ind. motor ..... Allis-Chalmers Mfg. Co.
Turbine, one, 300 kw., mixed-pressure, 125 lb., g., or 17 lb., abs. ..... Terry Steam Turbine Co.
Generator, one 300 kw., 3-phase, 60-cycle, 240-volt, 3,600 r.p.m., ..... Allis-Chalmers Mfg. Co.
Condenser, multijet, 10,000 lb. steam per hr., 1,000-g.p.m. condensing water, 27 in. vac. ..... Schutte & Koerting Co.
Circulating pumps, two, 1,000 g.p.m., 35- and 45-ft. hd.; driven by one 30-hp. ind. motor ..... Allis-Chalmers Mfg. Co.
Cooling, tower, one, atmospheric, 1,500-g.p.m., 14x70 ft. and 34 ft. high, 22,000 gal. basin ..... Water Cooling Equipt. Co.
Grating, subway, turbine op. gallery ..... Irving Iron Works Co.
Oil separator, 14-in. receiver type ..... Power Plant Specialty Co.
Switchboard, remote control, and oil switches, ..... Westinghouse Elec. & Mfg. Co.
Recording pressure gages, two-pointer ..... Foxboro Co.
Recording thermometer, two-pointer, on cond. water .. Foxboro Co.
Indicating pressure gages ..... Crosby Steam Gage & Valve Co.
Mercury column ..... Precision Thermometer & Instrument Co.
Vacuum gages ..... Crosby Steam Gage & Valve Co.


## *Maintain or Replace?*

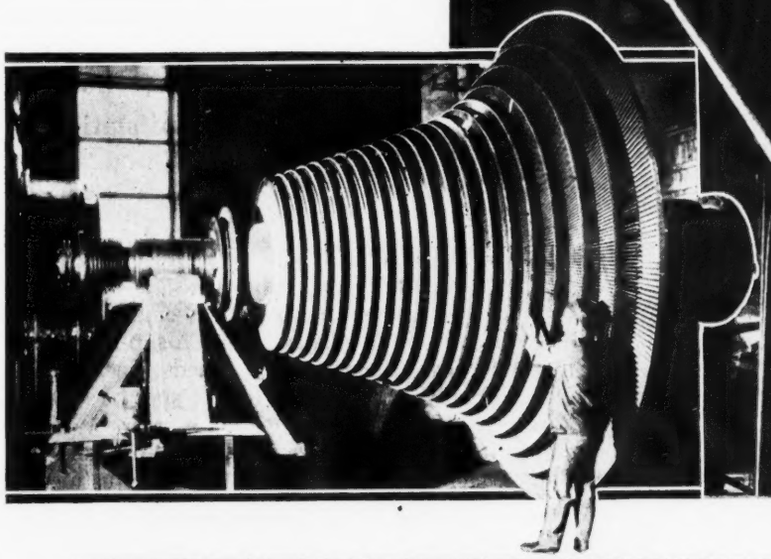
**WHICH is cheaper, all things considered: (1) Renovate the old machine so that it will carry on for some years? (2) Scrap it for a new one of better efficiency?**

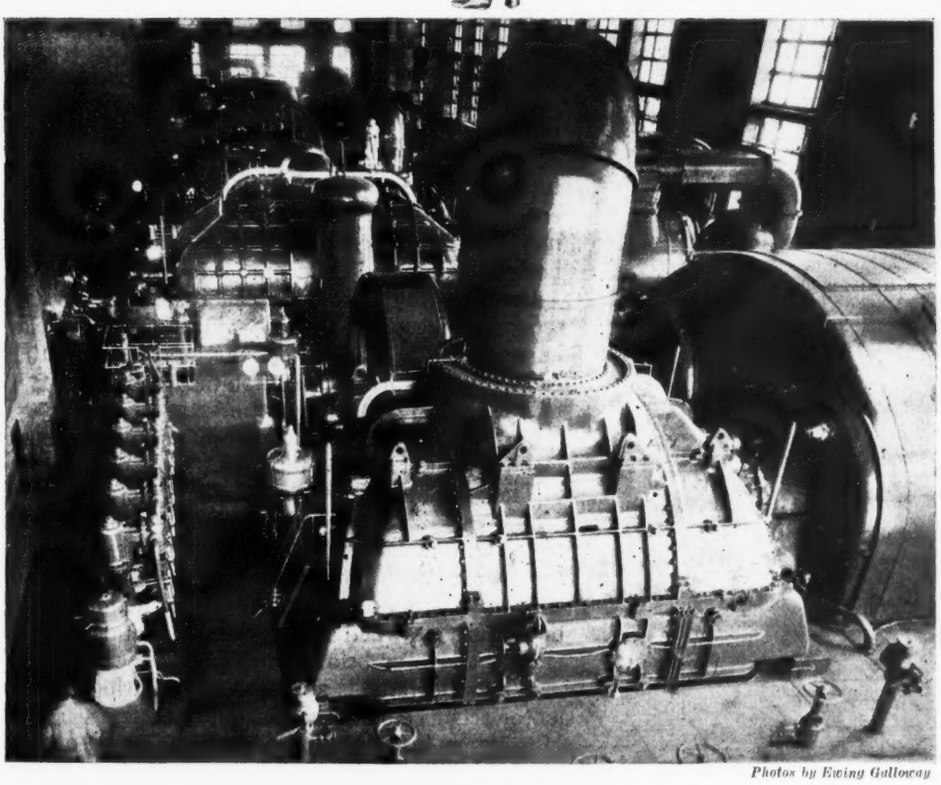
## Power, Aug. 26

will point the answer to this and other practical maintenance problems, with applications to COAL HANDLING AND FIRING EQUIPMENT, TURBINES, ENGINES, INSTRUMENTS, ELECTRICAL MACHINERY, REFRIGERATION, OIL ENGINES, ETC.

# Lights and Shadows of Hell Gate

*Modern camera technique finds mystery and drama in world's largest power plant*





Top—Tube-lined boiler walls rise like banks of pipes in a great cathedral organ

Center — The huge rotor of a Hell Gate turbine is as graceful in outline and detail as a Japanese fan

Bottom — To prove that the lens is mightier than the lathe the cameraman puts a few kinks in a 160,000-kw. turbine. In this single room a total capacity of 605,000 kw. is installed

*Photos by Ewing Galloway*

# *A New System of*

# Speed Control for A.-C. Motors

By ALLEN M. ROSSMAN
*Research Engineer,*
*Sargent & Lundy, Inc., Chicago, Ill.*

**A constant-speed squirrel-cage induction motor supplies the base speed, while a direct-current motor, usually of much smaller size than the former, is used to vary the speed from the base. This system is being used on power house auxiliary applications in several stations**

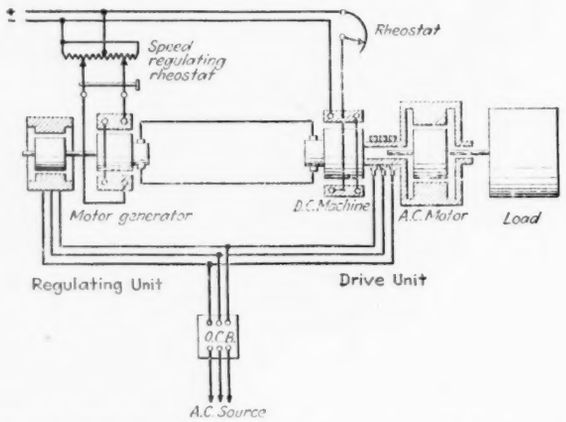



**Fig. 1—Elementary diagram of connections of the speed control system**

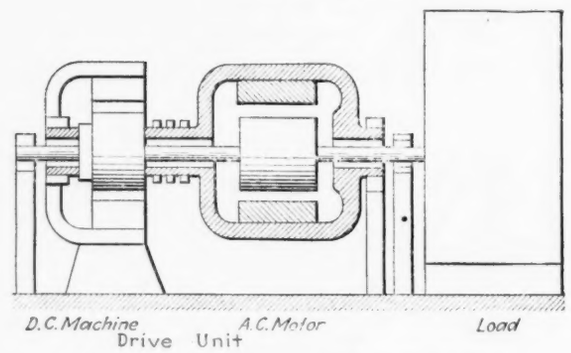



**Fig. 2—Direct-connected form of drive unit**

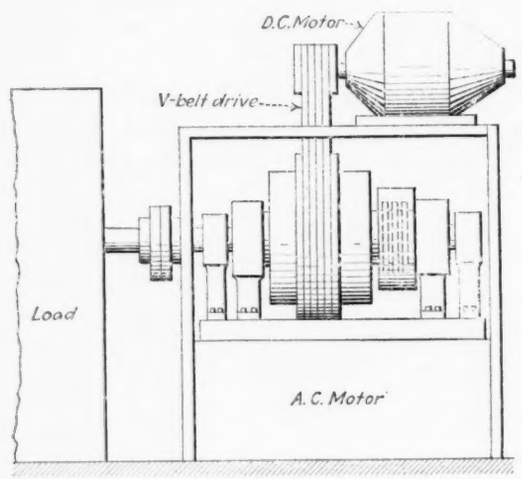



**Fig. 3—Form of drive unit employing a multiple V-belt**

ALTERNATING-CURRENT motors in their simplest forms are inherently constant-speed machines. Adjustable-speed designs entail a sacrifice of either efficiency or simplicity. When a slip-ring induction motor is operated at reduced speeds the resistance losses are directly proportional to the speed reduction, and, furthermore, its speed regulation is poor. With the commutator-type alternating-current motor and the Scherbius system of speed control, speed adjustment is obtained by sacrificing simplicity. A new system of alternating-current motor speed control has been developed that utilizes the simplest types of electrical machines, is efficient over a wide speed range, and has a good speed regulation characteristic.

In this system 2 two-machine units are used, a drive unit and a regulating unit, Fig. 1. The drive comprises a constant-speed alternating-current motor of either the induction or the synchronous type, and an adjustable-speed direct-current motor. The alternating-current motor differs mechanically from standard types in that both the rotor and the frame, which is usually called the stator, are free to rotate about their common axis. The rotor is connected to the load, and the frame to the direct-current motor. The frame may be rotated by the direct-current motor or the operation may be reversed. Current is delivered to the alternating-current motor windings through collector rings. The direct-current motor is a standard shunt-wound type with separately excited field.

The regulating unit is a standard motor-generator set. Voltage of its direct-current machine is adjustable between zero and maximum, in either a positive or a negative direction. The direct-current regulating machine sometimes acts as a generator and sometimes as a motor, depending on whether the main induction motor is operating above or below synchronous speed.

When its frame is at rest the alternating-current drive motor acts as a standard machine running at rated speed. If a higher load speed is desired the direct-current voltage is built up by increasing the excitation of the direct-

current regulating machine, which then delivers energy to the direct-current drive machine. The latter then acts as a motor to drive the alternating-current motor's frame in the same direction as the rotor. With constant field excitation the direct-current drive machine tends to rotate at a speed in direct proportion to the voltage impressed on its terminals. The speed of the frame, and, hence, the increase in speed of the load, are thus built up in the same proportion.

If a lower load speed is desired, the voltage of the direct-current regulating machine is built up in the opposite direction. As a result, the alternating-current motor's frame drives its direct-current machine in a direction opposite to that of the rotor and causes it to deliver energy to the direct-current regulating machine, which, in turn, acts as a motor to drive its alternating-current motor as a generator. The latter then delivers energy to the alternating-current supply system. Decrease in speed of the load is at the same rate as the change in direct-current voltage.

Mechanical connection between the two machines of the drive unit may be one of several different forms. The direct-current machine may be direct connected to the rotating frame, Fig. 2; it may be connected through multiple V-belts, Fig. 3; or it may be belt, gear, or chain driven.

Another form of drive unit, somewhat different from that just described, employs a differential or a planetary gear in place of the rotating stator, Fig. 4. Here a standard alternating-current motor is connected to the internal gear, a standard direct-current motor is connected to the sun gear, and the load is connected to the cage that carries the planet gears. The method of speed control is the same as that used with the rotating-frame arrangement.

On loads in which the torque does not vary with the speed, the horsepower of the drive machines is directly proportional to the speed contributed by each to the load, at the extreme speed of the load. Maximum machine loading may occur at either maximum or minimum load speed, depending on which shows greater departure from the rated speed of the alternating-current motor. Usually the speeds are so chosen that variations, above and below that of the alternating-current motor, are the same. This gives the most economical design for constant-torque loads. On loads the torque of which decreases with the speed the speed range can be carried further in the negative direction than in the positive direction.

In the direct-connected form the direct-current drive machine must develop the same torque as the alternating-current motor. When a small speed range is required it becomes a high-torque, slow-speed machine. The belted and the geared types generally use a higher-speed, lower-torque direct-current machine, which is cheaper and more efficient than the direct-connected unit.

The rating of the regulating set, neglecting losses, is the same as the rating of the direct-current drive machine.

Energy delivered by the alternating-current motor to the load goes through but one machine. Energy delivered by the direct-current drive motor goes through three machines, namely, the two machines of the regulating unit and the direct-current drive machine. Energy delivered by the direct-current drive unit through the regulating unit to the supply system, to obtain a decrease in speed, passes through four machines. As the energy which undergoes the three or the four transformations is only that corresponding to the departure from the constant rated speed of the main motor, it is, for small speed changes, comparatively small. Over-all efficiency of a

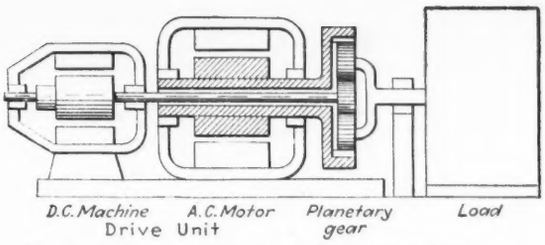



**Fig. 1—Form of drive unit using a planetary gear**

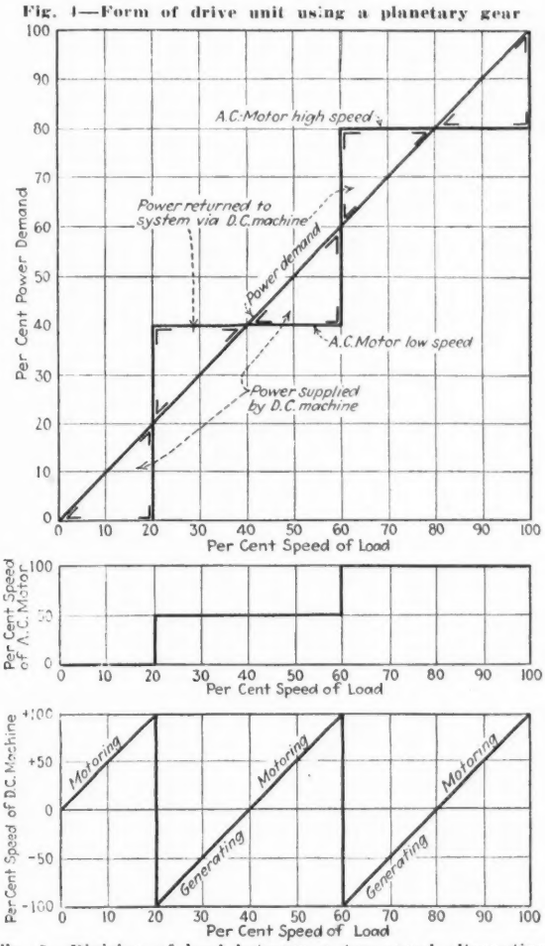



**Fig. 5—Division of load between a two-speed alternating-current motor and a direct-current machine connected to constant-torque load**

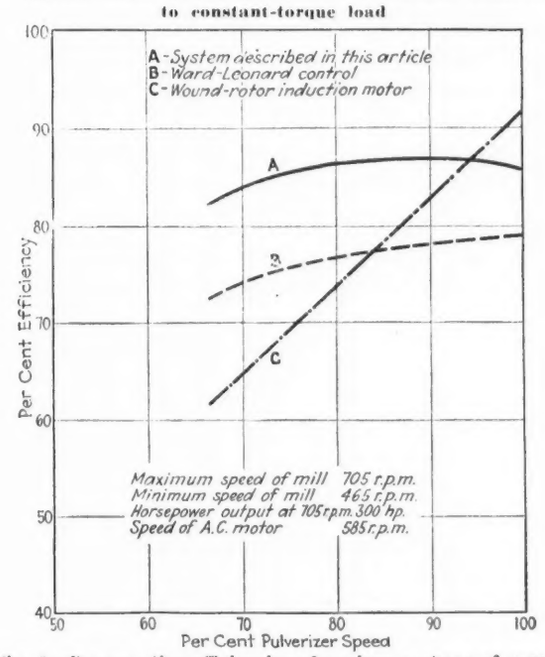

A - System described in this article
B - Ward-Leonard control
C - Wound-rotor induction motor
A
B
C
Maximum speed of mill 705 r.p.m.
Minimum speed of mill 465 r.p.m.
Horsepower output at 705 r.p.m. 300 hp.
Speed of A.C. motor 585 r.p.m.
Per Cent Efficiency
Per Cent Pulverizer Speed

**Fig. 6—Comparative efficiencies of various systems of speed control as applied to coal pulverizers**

drive designed to meet these conditions is therefore high. As the speed range is increased, efficiency decreases correspondingly.

As the speed of the drive unit is the sum, or difference, of the speeds of a constant-speed alternating-current motor and a constant-speed direct-current machine operating at practically constant voltage, for any speed setting it will show but little variation over a fairly wide range of torque.

Speed adjustments can be made in such small increments that the effect is substantially a smooth speed curve for the entire range of control, irrespective of changes in the load.

Should load conditions be such that the torque changes from positive to negative, the drive unit will first increase its speed slightly, then regenerate and deliver energy to the supply system. This characteristic has an application on hoists, on elevators, and in railway service. When used in railway service in connection with multi-speed

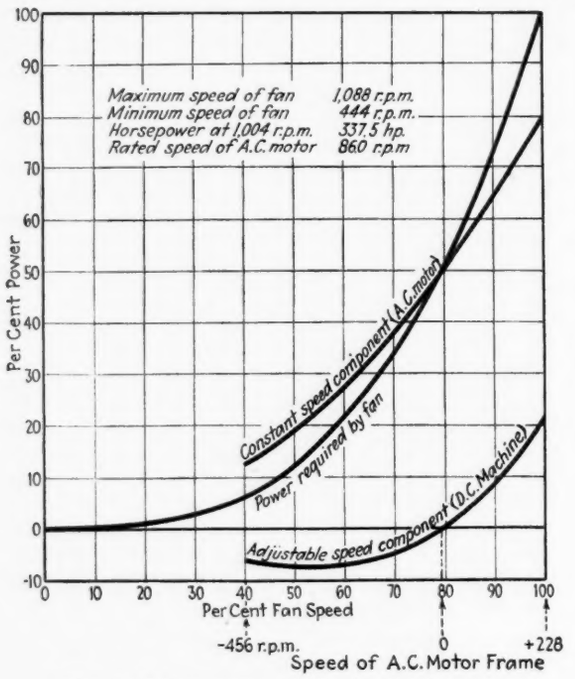

Maximum speed of fan 1,088 r.p.m.
Minimum speed of fan 444 r.p.m.
Horsepower at 1,004 r.p.m. 337.5 hp.
Rated speed of A.C. motor 860 r.p.m
Per Cent Power
Constant speed component (A.C. motor)
Power required by fan
Adjustable speed component (D.C. Machine)
Per Cent Fan Speed
-456 r.p.m.
0
+228
Speed of A.C. Motor Frame

**Fig. 7—Power curves for induced-draft fans**

alternating-current motors in a manner described further on in this article, regenerative braking can be carried all the way down to zero speed.

Where several motors must simultaneously follow a given speed cycle, as when driving fans or other power station auxiliaries, one regulating unit may be used to control several drive units. Where speed adjustments are required between individual drive units, a secondary adjustment can be made by independent field control of the individual direct-current drive machines.

When the torque decreases more rapidly than the speed, as with centrifugal pumps and fans, the lower end of the speed range may be extended beyond the limit of armature control, by field control of the direct-current drive machine. On such a load overspeed of the direct-current drive machine and the rotating frame, rather than overload, will generally establish the limit of speed reduction. This extension of the speed range by field control is shown on some of the characteristic curves.

A wide speed range under conditions approaching constant torque may be obtained by using a two-speed alternating-current motor and a smaller direct-current motor. For example, with a 600- and a 1,200-r.p.m. alternating-current motor and a direct-current drive machine giving a frame speed of plus or minus 300 r.p.m. it is possible to obtain a range of 1,500 to 0 r.p.m. A speed range of 1,500 to 900 r.p.m. is obtained on the high-speed winding, and a range of 900 to 300 r.p.m. on the low-speed winding. Then, by locking together the rotor and the frame of the alternating-current motor, a range of 300 to 0 with the direct-current machine alone may be obtained. By reversing the connections of the windings the same total speed range of 0 to 1,500 r.p.m. may be obtained in the opposite direction. This system is especially applicable to railway service, where, because several motors are used to make up the equipment of each locomotive or motor car, one or more of the alternating-current motors may be shifted from one speed to another while the others remain in service. Thus there is no break in the continuity of tractive effort during the transition period. Fig. 5 shows the division of load between alternating- and direct-current motors at the different speeds, assuming constant torque at all speeds.

Two units of the form shown in Fig. 2, each rated 300 hp. (a 250-hp. induction motor and a 50-hp. direct-current motor), capable of operating at any speed between the limits of 720 r.p.m. and 480 r.p.m., have been driving coal pulverizers in State Line power station, near Chicago, since April, 1929. Each drive unit has its own regulating unit. The load calls for constant torque at all speeds.

Twenty-four drive units of the form shown in Fig. 3 are now being built for the power station of the Super-Power Company of Illinois, Powerton, Ill. Twelve of

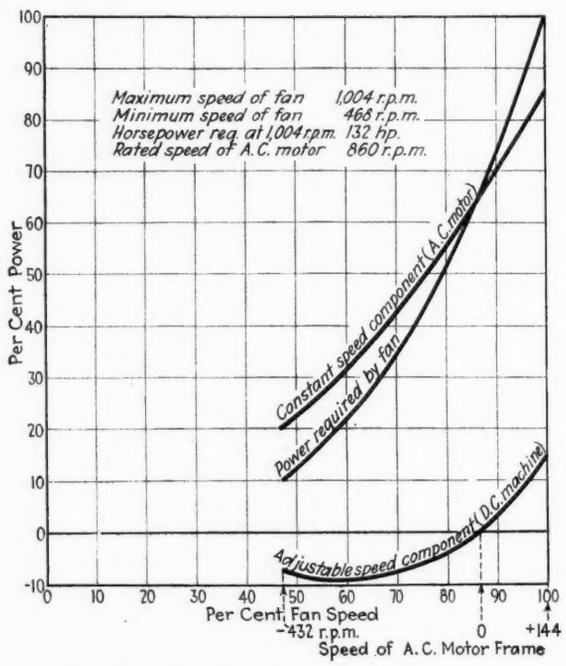

Maximum speed of fan 1,004 r.p.m.
Minimum speed of fan 468 r.p.m.
Horsepower req. at 1,004 r.p.m. 132 hp.
Rated speed of A.C. motor 860 r.p.m.
Per Cent Power
Constant speed component (A.C. motor)
Power required by fan
Adjustable speed component (D.C. machine)
Per Cent Fan Speed
-432 r.p.m.
0
+144
Speed of A.C. Motor Frame

**Fig. 8—Power curves for forced-draft fans**

these units each rated 419 hp. (a 330-hp. induction motor and an 89-hp. direct-current motor), capable of operating through a speed range of 100 to 40 per cent (1,088 to 444 r.p.m.), will drive induced-draft fans. The other twelve units, rated a 166 hp. (a 141-hp. induction motor and a 25-hp. direct-current motor), capable of operating through a speed range of 100 to 46 per cent (1,004 to 468 r.p.m.), will drive forced-draft fans. In this application each regulating unit controls two drive units. The direct-current drive machines and the regulating units are standard apparatus. These 24 motor units, aggre-

gating 7,020 hp., require but 1,140 kw. in motor-generator capacity for their control.

Preliminary designs have been prepared on two units each capable of delivering 2,500 hp. at 708 r.p.m. The alternating-current motor is rated 1,750 hp. at 495 r.p.m., and the direct-current machine is rated 750 hp. It is designed to give a speed range of 708 to 282 r.p.m.

Efficiency curves of the 300-hp. units which drive coal pulverizers in State Line station, in comparison with other systems of drive, are shown in Fig. 6. It will be noted that the new system shows an efficiency of between 82.5 and 86 per cent over its complete operating range. These figures include both the drive- and the regulating-unit losses. The direct-current motor with armature voltage control (Ward Leonard system) shows an efficiency about 8 per cent lower. The slip-ring induction motor shows 92 per cent efficiency at maximum speed, but its efficiency drops off on a straight line which would extend to zero efficiency at zero speed.

Fig. 7 shows the characteristics of the Powerton induced-draft fan drives. At maximum fan speed of 1,088 r.p.m. the alternating-current motor running at 860 r.p.m. furnishes 79 per cent $\frac{860}{1,088}$ of the total power, while the direct-current motor driving the rotating frame furnishes 21 per cent. At 79 per cent fan speed the frame is at rest and the alternating-current motor furnishes all the power. In Fig. 8 are shown the curves for the Powerton forced-draft fan drives. Because of a better correlation of fan and motor speeds, the alternating-current motor furnishes 85.5 per cent of the power required at maximum fan speed, leaving but 14.5 per cent to be supplied by the direct-current motor. The alternating-current motor supplies all the power at 85.5 per cent fan speed.

Because of the rapid decrease in power required as fan speed decreases, power delivered to the direct-current machine does not, in either the induced-draft or the forced-draft fan, exceed the power delivered by it at maximum fan speed. Advantage is taken of this characteristic to extend the speed control range to lower limits by weakening the field of the direct-current drive motor. On the induced-draft fan motors the range in the negative direction is doubled by using field control. On the forced-draft fan motors it is trebled.

The author wishes to acknowledge his indebtedness to R. B. Williamson of the Allis-Chalmers Manufacturing Company for the interest he has shown in this system and for the assistance he has rendered in bringing it to its present stage of development.

# Minimum Center-to-Center Spacing for Different Sizes of Pipe

IN LAYING OUT power plant and building piping, it is frequently necessary to run a number of pipe lines along the ceiling or wall, and as close together as possible. The three tables show the minimum center-to-center spacing for different sizes of pipe. No. I is for standard fittings, No. II for extra-heavy, and No. III for standard and extra-heavy pipe.

Suppose it is desired to run a 6-in. pipe with standard fittings as close to an 8-in. line of standard fittings as possible. The center-to-center distance necessary for these pipe lines is indicated in Table I. Enter the table at six in the lefthand vertical column of figures and proceed to the right until under the column headed by 8 in the top horizontal row of figures, the center-to-center distance is indicated as $13\frac{1}{4}$ in.

Had the pipe line been of extra heavy pipe and fittings, Table II should be used in the same manner, indicating a center-to-center distance of $14\frac{3}{4}$ in. If the 6-in. line is of extra heavy pipe and the 8-in. line of standard pipe the center-to-center distance is shown by Table III to be 14 inches. The center-to-center dimensions given allow one inch clearance between adjacent flanges. They do not, however, provide for pipe covering, the thickness of which should be added to the dimensions given in the tables.

TABLE I—STANDARD FLANGES AND FITTINGS

| Standard Pipe Size | Standard Pipe Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| 1 | 2 | 7 | $7\frac{3}{4}$ | $8\frac{1}{2}$ | $9\frac{1}{2}$ | $10\frac{3}{4}$ | 12 | $13\frac{1}{2}$ |
| 2 | 3 | $7\frac{3}{4}$ | $8\frac{1}{2}$ | $9\frac{1}{4}$ | $10\frac{1}{4}$ | $11\frac{1}{2}$ | $12\frac{3}{4}$ | $14\frac{1}{4}$ |
| 3 | 4 | $8\frac{1}{2}$ | $9\frac{1}{4}$ | 10 | 11 | $12\frac{1}{4}$ | $13\frac{1}{2}$ | 15 |
| 4 | 6 | $9\frac{1}{2}$ | $10\frac{1}{4}$ | 11 | 12 | $13\frac{1}{4}$ | $14\frac{1}{2}$ | 16 |
| 6 | 8 | $10\frac{3}{4}$ | $11\frac{1}{2}$ | $12\frac{1}{4}$ | $13\frac{1}{4}$ | $14\frac{1}{2}$ | $15\frac{3}{4}$ | $17\frac{1}{4}$ |
| 8 | 10 | 12 | $12\frac{3}{4}$ | $13\frac{1}{2}$ | $14\frac{1}{2}$ | $15\frac{3}{4}$ | 17 | $18\frac{1}{2}$ |
| 10 | 12 | $13\frac{1}{2}$ | $14\frac{1}{4}$ | 15 | 16 | $17\frac{1}{4}$ | $18\frac{1}{2}$ | 20 |
| 12 | | | | | | | | |

TABLE II—EXTRA-HEAVY FLANGES AND FITTINGS

| Extra-Heavy Pipe Size | Extra-Heavy Pipe Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| 1 | 2 | $7\frac{1}{2}$ | $8\frac{3}{8}$ | $9\frac{1}{4}$ | $10\frac{1}{2}$ | $11\frac{3}{4}$ | 13 | $14\frac{1}{2}$ |
| 2 | 3 | $8\frac{3}{8}$ | $9\frac{1}{4}$ | $10\frac{1}{8}$ | $11\frac{3}{8}$ | $12\frac{5}{8}$ | $13\frac{7}{8}$ | $15\frac{3}{8}$ |
| 3 | 4 | $9\frac{1}{4}$ | $10\frac{1}{8}$ | 11 | $12\frac{1}{4}$ | $13\frac{1}{2}$ | $14\frac{3}{4}$ | $16\frac{1}{4}$ |
| 4 | 6 | $10\frac{1}{2}$ | $11\frac{3}{8}$ | $12\frac{1}{4}$ | $13\frac{1}{2}$ | $14\frac{3}{4}$ | 15 | $17\frac{3}{4}$ |
| 6 | 8 | $11\frac{3}{4}$ | $12\frac{5}{8}$ | $13\frac{1}{2}$ | $14\frac{3}{4}$ | 16 | $17\frac{1}{4}$ | 19 |
| 8 | 10 | 13 | $13\frac{7}{8}$ | $14\frac{3}{4}$ | 15 | $17\frac{1}{4}$ | $18\frac{1}{2}$ | 20 |
| 10 | 12 | $14\frac{1}{2}$ | $15\frac{3}{8}$ | $16\frac{1}{4}$ | $17\frac{3}{4}$ | 19 | 20 | $21\frac{1}{2}$ |
| 12 | | | | | | | | |

TABLE III—STANDARD AND EXTRA HEAVY FLANGES AND FITTINGS

| Extra-Heavy Pipe Size | Standard Pipe Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| 1 | 2 | $7\frac{1}{4}$ | 8 | $8\frac{3}{4}$ | $9\frac{3}{4}$ | 11 | $12\frac{1}{4}$ | $15\frac{3}{4}$ |
| 2 | 3 | $8\frac{1}{8}$ | $8\frac{7}{8}$ | $9\frac{5}{8}$ | $10\frac{5}{8}$ | $11\frac{7}{8}$ | $13\frac{1}{8}$ | $14\frac{5}{8}$ |
| 3 | 4 | 9 | $9\frac{3}{4}$ | $10\frac{1}{2}$ | $11\frac{1}{2}$ | $12\frac{3}{4}$ | 14 | $15\frac{1}{2}$ |
| 4 | 6 | $10\frac{1}{4}$ | 11 | $11\frac{3}{4}$ | $12\frac{3}{4}$ | 14 | $15\frac{1}{4}$ | $16\frac{3}{4}$ |
| 6 | 8 | $11\frac{1}{2}$ | $12\frac{1}{4}$ | 13 | 14 | $15\frac{1}{4}$ | $16\frac{1}{2}$ | 18 |
| 8 | 10 | $12\frac{3}{4}$ | $13\frac{1}{2}$ | $14\frac{1}{4}$ | $15\frac{1}{4}$ | $16\frac{1}{2}$ | $17\frac{3}{4}$ | $19\frac{1}{4}$ |
| 10 | 12 | $14\frac{1}{4}$ | 15 | $15\frac{3}{4}$ | $16\frac{3}{4}$ | 18 | $19\frac{1}{4}$ | $20\frac{3}{4}$ |
| 12 | | | | | | | | |

# CHARTS Help to Eliminate 50 Per Cent Waste

**Simple heat-balance charts based on actual tests in a box-board mill showed preventable losses totaling 50 per cent of the coal fired**

▼

By CORNELIUS G. WEBER

NECESSITY of maintaining a proper balance between power and heating or steam-process loads to secure maximum economy of operation probably requires no mention in these days of progressive management. However, the degree to which a lack of balance may affect profits in plants wherein these matters are not given proper consideration may not be fully appreciated by those who have been in the habit of leaving things alone so long as the wheels kept turning.

This article presents a schematic graphic heat balance based upon actual tests and analyses made in a box-board mill, in order to show the extent to which losses may occur in plants that do not receive sufficient attention in this respect. This case is probably an extreme of wasteful operation, but should be indicative of the possible existence of others that might be equally bad.

This plant was completely tested with instruments, the tests having included boiler evaporation tests, consumption tests of all major steam equipment, power developed by engines, power developed and water consumed by waterwheels. Major equipment in the plant comprised the following:

BOILER ROOM—Two 4,000-sq.ft. stoker-fired water-tube boilers, designed for 150 lb. pressure. Two 1,500-sq.ft., hand-fired, return-tubular boilers, designed for 150 lb. pressure. (The necessary feed water-heater, pumps, etc., but no mechanical coal or ash handling equipment.)

MAIN ENGINE ROOM—One 18x32x48-in. compound condensing engine driving a main lineshaft by belt. One simple slide-valve engine belted to a 25-kw. generator operating the lighting system. (The main engine was old and badly worn. The valves leaked considerably. Condenser leakage interfered with vacuum.)

MACHINE ROOM—Two constant-speed and two variable-speed slide-valve engines driving two box-board machines. (These engines discharged their exhaust steam into the general exhaust system, which supplied the driers of the board machines. While of relatively small size, the engines leaked to such an extent that their exhaust met the demands of the board machines and beaters.)

WATER-POWER PLANT—Three wheels of 200 hp. each operating under an 8-ft. head and connected to the main lineshaft by bevel gearing. One wheel of 100 hp. mechanically connected to a second lineshaft.

Fig. 1 shows the schematic layout and a graphic heat balance drawn to scale, the widths of the bands representing the hourly heat consumption in thousands of B.t.u. For simplicity one engine is shown to represent the four non-condensing engines driving the board machines, and, likewise, one waterwheel in the diagram represents the four installed. Viewed from the outside, the plant did not appear unusually wasteful, since there was practically no steam escaping by way of the exhaust pipes. However, an examination of Fig. 1, and the quantities shown, at once reveals two great sources of waste in the engines.

First, the four paper machine engines, which devel-

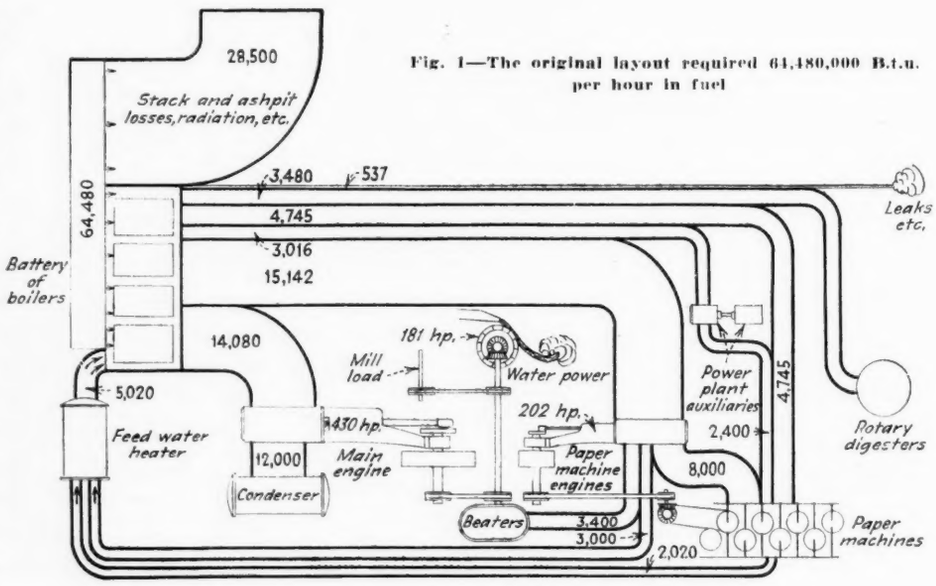



**Fig. 1—The original layout required 64,480,000 B.t.u. per hour in fuel**

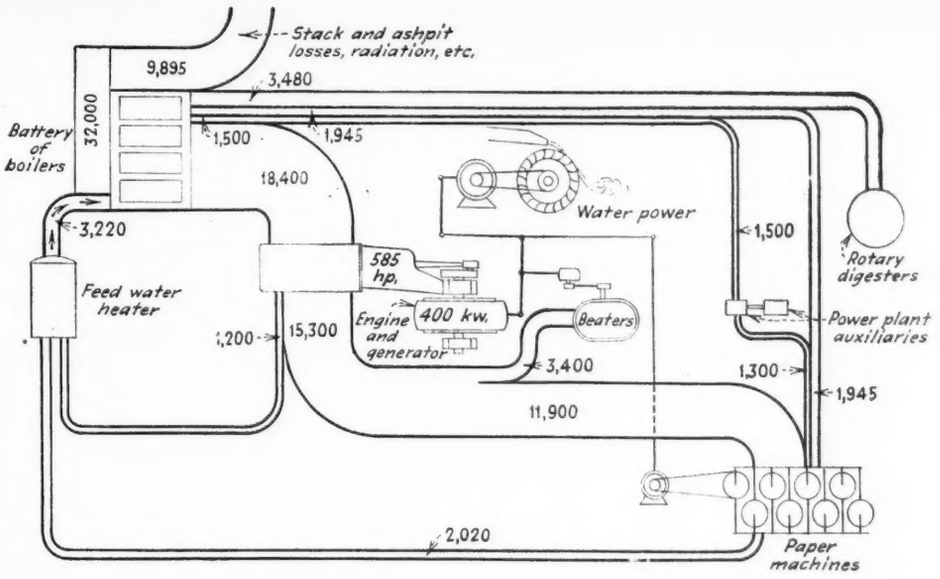



**Fig. 4 — New layout cuts fuel requirements to 32,000,000 B.t.u. per hour, a saving of 50 per cent**

▼

oped a total of only 202 hp., absorbed 15,142 thousand B.t.u. per hour, or 75,000 B.t.u. per horsepower-hour. This large heat consumption was due to the worn condition of cylinders and valves. It is true that the discharged heat was reclaimed; but the small amount of byproduct mechanical energy generated necessitated operation of a condensing engine which discharged its exhaust steam into the river. This engine, likewise, was worn and wasteful, consuming far more steam than equipment of its type ordinarily requires when in good condition.

Over-all efficiency of the boiler plant was only 59 per cent, due to faulty settings and operation.

Incidentally, the water-power plant, in its leaky condition, with its cumbersome drive through gears and a long shaft, which was out of alignment, transformed only 49 per cent of the theoretical power in the water into useful energy at the mill. The large heat consumption proportionally increased the steam required by the plant auxiliaries.

Rehabilitation was approached from a heating-load viewpoint by first considering the total process steam requirements, the extent to which live steam could be replaced by exhaust steam, and, thereafter, what amount of energy could be generated as a byproduct from the low-pressure steam discharged by a modern non-condensing engine or turbine acting as a reducing valve.

Electrification of the entire plant was warranted by the many economies to result from reduced friction load, elimination of engine men, reduced maintenance, and improved flexibility.

It was also clear that resetting of the boilers and other changes in the boiler plant would improve conditions materially and raise the over-all boiler efficiency to 72 per cent.

Rehabilitation of the water-power plant indicated that 70 per cent of the dependable amount of energy in the stream could be converted into useful electric energy. When all matters were analyzed it was found that 25,325 thousand B.t.u. per hour, in conjunction with rehabilitated water power, would furnish more than all of the plant's requirements, instead of 41,000 thousand B.t.u. formerly necessary.

To generate 25,325 thousand B.t.u. per hour as steam with improved boiler efficiency represented a coal input of only 32,000 thousand B.t.u., or 50 per cent of 64,480 thousand required under the old conditions.

Incidentally, mechanical coal and ash-handling showed further substantial economies through replacement of expensive hand labor.

The plant manager may be aware of inefficiencies in his own plant, but not until he obtains a complete quantitative analysis and heat-balance figures or diagrams will he be able to obtain the clear idea of operations needed for making decisions.

# Computing the Capacity of a Refrigerating Machine

By Ray B. Wolf

WITH the aid of properly constructed charts, the rated tonnage and the developed tonnage of ammonia compressors can easily be ascertained without lengthy calculations when computing capacities from data collected from engine room log sheets. The charts, Figs. 1 and 2, were made with this in mind, and they will be found accurate enough for the purpose for which they were made. No allowance was made for superheat in the suction gas or other losses due to machine imperfections or faulty plant layout. A constant will have to be arrived at, to use charts, as will be later explained. This constant will have to be calculated for a particular machine, but once found will remain the same for any one machine as long as the physical dimensions and the speed remain the same.

## Calculating Tonnage

Through the use of Fig. 1, the rated tonnage of a given ammonia compressor can be determined in the range of pressures on the suction side of from 0 to 40 lb. gage, and on the discharge side of from 95 to 215 lb., gage with volumetric efficiencies ranging from 65 to 100 per cent. One can find the tonnage developed for any number of hours per day of an ammonia compressor from Fig. 2, if the rated tonnage is known or is found by the use of Fig. 1.

The piston diameter in inches and the stroke in inches of the compressor under consideration must be known, likewise its speed in revolutions per minute. A constant is found by the formula $\frac{D^2 \times S \times N}{1,273}$ where $D$ is the

diameter in inches, $S$ the stroke, and $N$ the number of revolutions per minute.

This is for a single-cylinder, single-acting machine; for a multi cylinder, single-acting machine, the number arrived at for a single cylinder is multiplied by the number of cylinders to obtain the correct constant. If the machine is double-acting the result is multiplied by 2. Examples:

1. To find the constant for a 10x10-in., twin-cylinder,

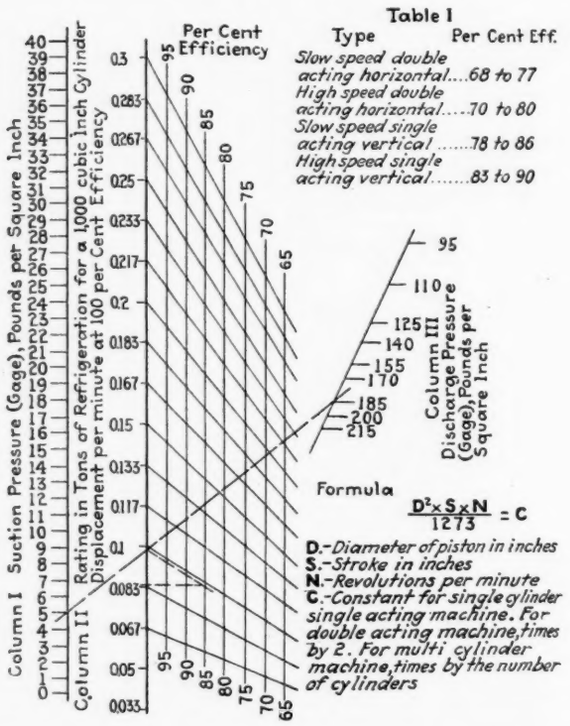


Table I
Type Per Cent Eff.
Slow speed double acting horizontal....68 to 77
High speed double acting horizontal....70 to 80
Slow speed single acting vertical.....78 to 86
High speed single acting vertical.....83 to 90
Per Cent Efficiency
Column I Suction Pressure (Gage), Pounds per Square Inch
Column II Rating in Tons of Refrigeration for a 1,000 cubic Inch Cylinder Displacement per minute at 100 per Cent Efficiency
Column III Discharge Pressure (Gage), Pounds per Square Inch
Formula
$\frac{D^2 \times S \times N}{1273} = C$
D.-Diameter of piston in inches
S.-Stroke in inches
N.-Revolutions per minute
C.-Constant for single cylinder single acting machine. For double acting machine, times by 2. For multi cylinder machine, times by the number of cylinders

**Fig. 1—A chart to permit rapid calculation of refrigerating duty**

vertical, single-acting compressor running at 200 revolutions per minute. Substituting for the formula we find $\frac{10^2 \times 10 \times 200}{1{,}273} = 157$. This number times 2 equals 314, the correct constant to use for this machine at this speed.

Knowing the average pressures under which a machine operates, in column I of Fig. 1, find the suction pressure and in column III the discharge pressure. Connect these two points by means of a straight-edge, and the point crossed in column II will be the rating in tons refrigeration for a machine of 1,000 cu.-in. displacement per minute at 100 per cent efficiency. As the volumetric efficiency is always less than 100 per cent, the efficiency of the machine under consideration must be determined; by referring to Table I the expected efficiencies of different types of compressors can be found. Now, knowing the efficiency, the curve starting at the 100 per cent line in column II is followed until it touches the line of efficiency determined. From that point the horizontal line is followed to column II, and the number found will be the actual tonnage developed. This number times the constant for the machine under consideration will give the rated tons of refrigeration for 24 hr. at the given pressures and volumetric efficiency.

For example, to find the tonnage developed per hour by a machine with a constant of 314, working under average pressures of 5 lb. gage on the suction side and 185 lb. gage on the discharge side, with a volumetric efficiency of 85 per cent.

Connecting 5 in column I and 185 in column III, 0.098 is found in column II. Following the curve starting at 0.098 on the 100 per cent efficiency line, the 85 per cent line is crossed. From this point a line is drawn horizontally to column II, and 0.083 found. This times the constant 314 gives the rated tonnage for 24 hr. at 85 per cent efficiency, or 26+ tons.

Knowing the rated tonnage of an ammonia compressor and wishing to know the tonnage developed for any number of hours in a day, Fig. 2 is used. Under column I of Fig. 2 is the rating in tons per 24 hr., in column II the number of hours per day, and in column III the tonnage for a given number of hours. To use the chart a rule is placed across the point of the rated tonnage of the machine in column I and the point in column II of the number of hours under consideration, finding in

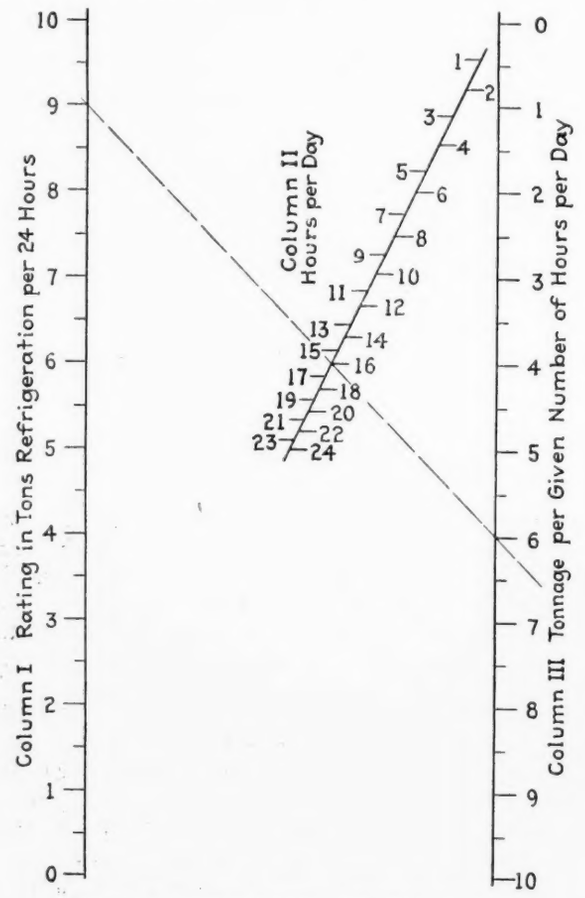

Column I Rating in Tons Refrigeration per 24 Hours
Column II Hours per Day
Column III Tonnage per Given Number of Hours per Day

**Fig. 2—Finding the duty performed per hour**

column III the developed tonnage for that number of hours.

For example, the dotted line shows that a machine rated at 9 tons per day when operated for 16 hr. will give 6 developed tons. The figures in columns I and II are from 0 to 10 and can be used for any tonnage by properly placing the decimal in the answer.

✦

BLUE GLASS DISCOURAGES ALGAE—At the Golpa Zschornewitz plant of the German Electric Power Corporation a great amount of trouble was encountered from the growth of algae in the water used for cooling the transformer oil. By housing the cooling tanks and glazing all windows with blue glass the growth was greatly reduced.

# Automatically Controlled Gas-Booster Compressor

By C. M. Sagmoen
*General Electric Company, Minneapolis, Minn.*

THE Minneapolis Gas Light Company has installed a reciprocating booster compressor in its line which feeds the town of Hopkins. This booster station is entirely automatic and is unattended. It is several miles from the city limits. The compressor is driven by a 25-hp., 220-volt, 3-phase motor, operated by a magnetic switch and two pressure governors in conjunction with a 220-volt time switch having three "on" and three "off" periods.

The maximum pressure on which this line operates is about 80 lb. and the minimum pressure that can be allowed is 20 lb. The equipment is limited to three operations a day, except in extreme emergency, and the time switch is set to start the compressor at 9 a.m., 2 p.m., and 8 p.m. The time switch is wired in series with contacts on one of the pressure governors, which is set to close at 60 lb. and to open at about 80 lb. The time switch will start the equipment if the pressure drops down to 60 lb. The time switch is set to run the equipment a maximum time of two hours for each cycle of operation. If the pressure reaches 80 lb. before the two-hour period is up, the pressure switch shuts off the motor.

The other pressure switch is set for limits of 20 lb. minimum and 80 lb. maximum and is wired in parallel with the closing coil on the magnetic switch. This pressure governor is used only if the pressure drops down to 20 lb. when the equipment will start at any time.

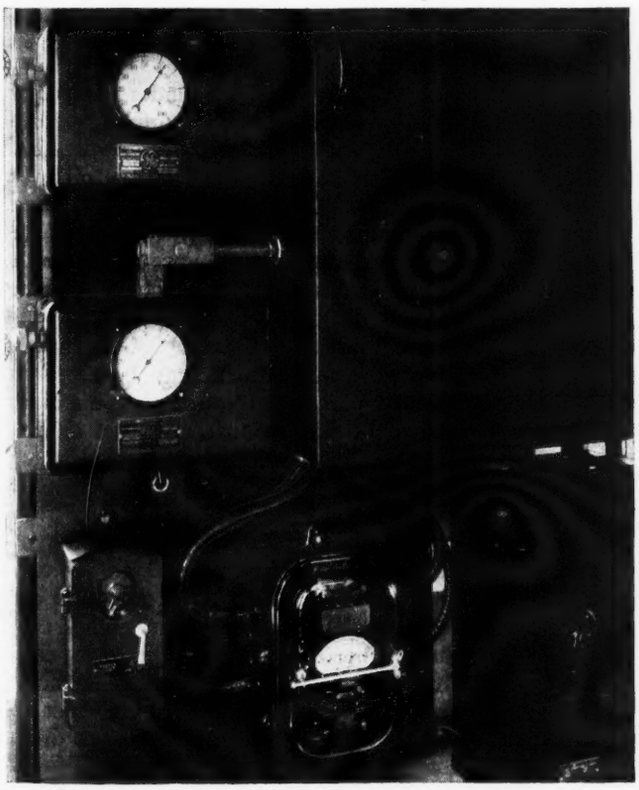


**Fig. 2—Control and metering equipment for the booster motor**
The two pressure governors are shown in the upper left, and the time switch in the lower left-hand corner.

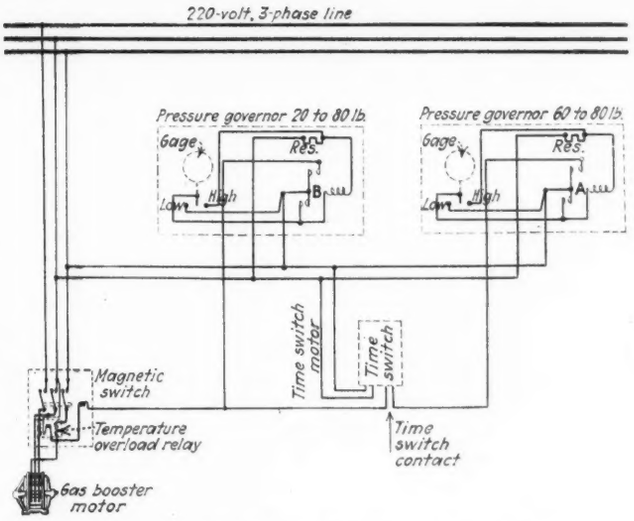



**Fig. 1—Diagram of the booster motor and contact connections**

The diagram shows the connections for the equipment. Say the pressure drops to where the low-pressure contact on the 60- to 80-lb. governor closes. This will complete a circuit from the line through the low contact, the coil and resistance to the other side of the line. Energizing this circuit causes switch *A* to close its top and bottom contacts. The bottom contact on *A* provides a holding circuit for the coil so that it will remain energized after the low contact opens. The top contact of switch *A* is in series with the time-switch contact, and the booster motor cannot start, except in an emergency, until the time-switch contact closes.

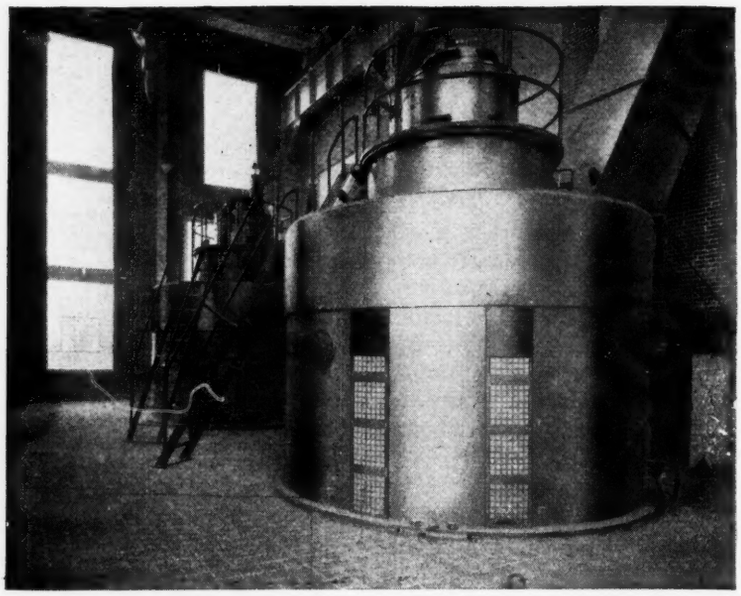
When the time-switch contact closes, a circuit is completed, for the booster motor's switch coil, from the middle leg of the power line through the contacts of the overload relay, the time-switch contact, pressure-governor top contact *A* and to the line. Energizing this circuit causes the booster motor's contactor to close and the motor to start. If the pressure reaches the high limit before the time switch opens, the high contact on the 60- to 80-lb. governor closes and short circuits the coil on contact *A*, and this contact drops open and stops the motor.

Should the pressure drop to that for which the low contact is set on the 20- to 80-lb. governor, that contact would close and energize the coil on switch *B*. Closing switch *B* completes a circuit for the coil on the motor's contactor, without the time switch's contact closing. Thus normally the motor is under the control of the time switch, but in an emergency low-pressure the booster motor will be started automatically, independently of the time switch. This arrangement insures the pressure's being maintained with a minimum starting and stopping of the motor, and, consequently, a minimum wear on the equipment.

✦

Living Costs Boosted by City Smoke Soot—Soot from burning coal costs each city dweller an average of $15 annually aside from its "incalculable detriment to the nerve force and health of the nation," Dr. Gustav Egloff reveals from a survey through the American Chemical Society. He points out that the damage done by soot from smoke of solid fuel amounts to over $500,000,000 in the United States annually. "The entire replacement of coal by gas is a worthy goal," the report says. "The use of gas means domestic convenience, industrial efficiency, and smokeless cities."

# Caring for Oil in Hydro-Electric Plants



This plant has two 33,000-hp. units operating under a 660-ft. head

**How lubricating and insulating oils are kept in good condition in a large plant. A description of handling and treating systems.**

By J. ELMER HOUSLEY

*Superintendent*
*Tallassee Power Company*
*Alcoa, Tenn.*

OIL bulks large in more than one way in hydro-electric plant operation. Many operating problems center about the care as well as the use of oil. For the purpose of illustrating one method of handling and taking care of oil, a description of the system in the Santeetlah power house of the Tallassee Power Company may be of interest.

The plant contains two vertical Francis-type 33,000-hp. units, operating at 450 r.p.m. under a 660-ft. head. The turbines are equipped with oil-lubricated babbitted guide bearings of relatively short length. Generators of 25,000-kva. capacity are coupled to the turbines by a short shaft. The thrust load of each unit is carried on a Kingsbury bearing, and two guide bearings are used in the generators.

The oiling system on the turbines is separate from that of the generator. A filter and sump tank is on the wall of the foundation several feet above the turbine bearing housing. Any entrained water from condensation or leakage settles out in the tank, and cloth-bag filters catch dirt and sediment. A pump for returning the oil to the sump tank is geared to the turbine shaft. A motor-driven pump is used during starting. Oil is pumped from a similar adjacent tank to the Kingsbury and guide bearings by a pump geared to the generator shaft. The Kingsbury bearing well is equipped with water-cooling coils. Medium-heavy oil is used in the turbine and generator systems.

Oil is used as a transmission agent for operating the turbine gates by servo-motor cylinders under control of the governor. Two governor pressure tanks are filled two-thirds with oil and one-third with air. A pressure of 150 lb. per square inch is maintained on the oil by a gear-type pump driven by a 25-hp. direct-current motor. One oil pump is operated continuously to supply the governors on the two turbines, and pressure regulation is secured by the use of an unloading valve. The same type of oil is used in the governors as in the turbine and generator lubrication system. As discussed later, the oil in the governor system may be piped to the central conditioning plant for treatment. This oil is filtered every three months to remove any dust or dirt that may have entered the sump tank and to clear up any sludging from contact with the air in this tank. The sump tank is emptied and cleaned once a year.

Seven transformers, one a spare—rated at 8,333 kva., oil-insulated, water-cooled, 13,200 to 150,000 volts—each contain 3,600 gal. of oil. Those in operation are piped for filling or circulation of oil from each transformer. A drain connection is made between each transformer and the transformer-oil storage tank, holding 3,880 gal., for quickly emptying a transformer in case of trouble. A U-trap at the entrance of the drain pipe to the storage tank prevents circulation of air through the overflow pipe, which disposes of oil to the sewer in event the tank becomes filled. The overflow is connected into the bottom of the U-trap as shown in the diagram in the upper right-hand corner of

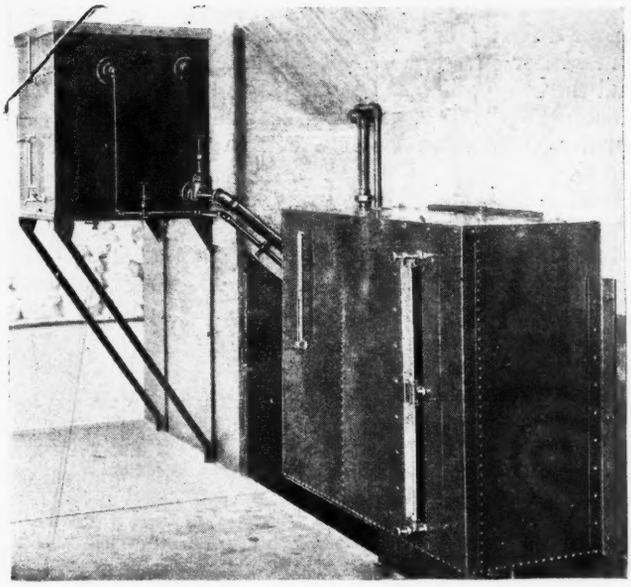


**Fig. 1—Oil sump and filter tanks for turbine guide bearing, generator guide bearings and thrust bearing**

Fig. 2. This makes, in effect, a double trap to protect both the drain pipe and the storage tank. A U-trap is necessary in the drain pipe to the storage tank to prevent breathing in the pipe between the transformer and the storage tank, and to prevent circulation of air in the storage tank through the connections to the sewer and the air vent on the tank. A word of caution is necessary to operators to insure that the valve of the air vent on the storage tank is always opened before discharging oil from a transformer to the storage tank, otherwise pressure builds up in the tank and the oil is discharged to the sewer. The storage tank must be equipped with an air vent large enough to release the air in the tank as it is displaced by entering oil.

Three high-rupturing-capacity oil circuit breakers are installed, two on the 150,000-volt transmission lines leaving the station and one as a tie between the two sections of high-tension bus. The nine tanks each hold 2,200 gal., and a storage tank of 6,680 gal. capacity will store the oil from one complete switch during repairs. Piping is arranged for filling or circulation of oil for conditioning, and connections are provided for draining the tanks.

Transformer and switch oil are tested monthly. A

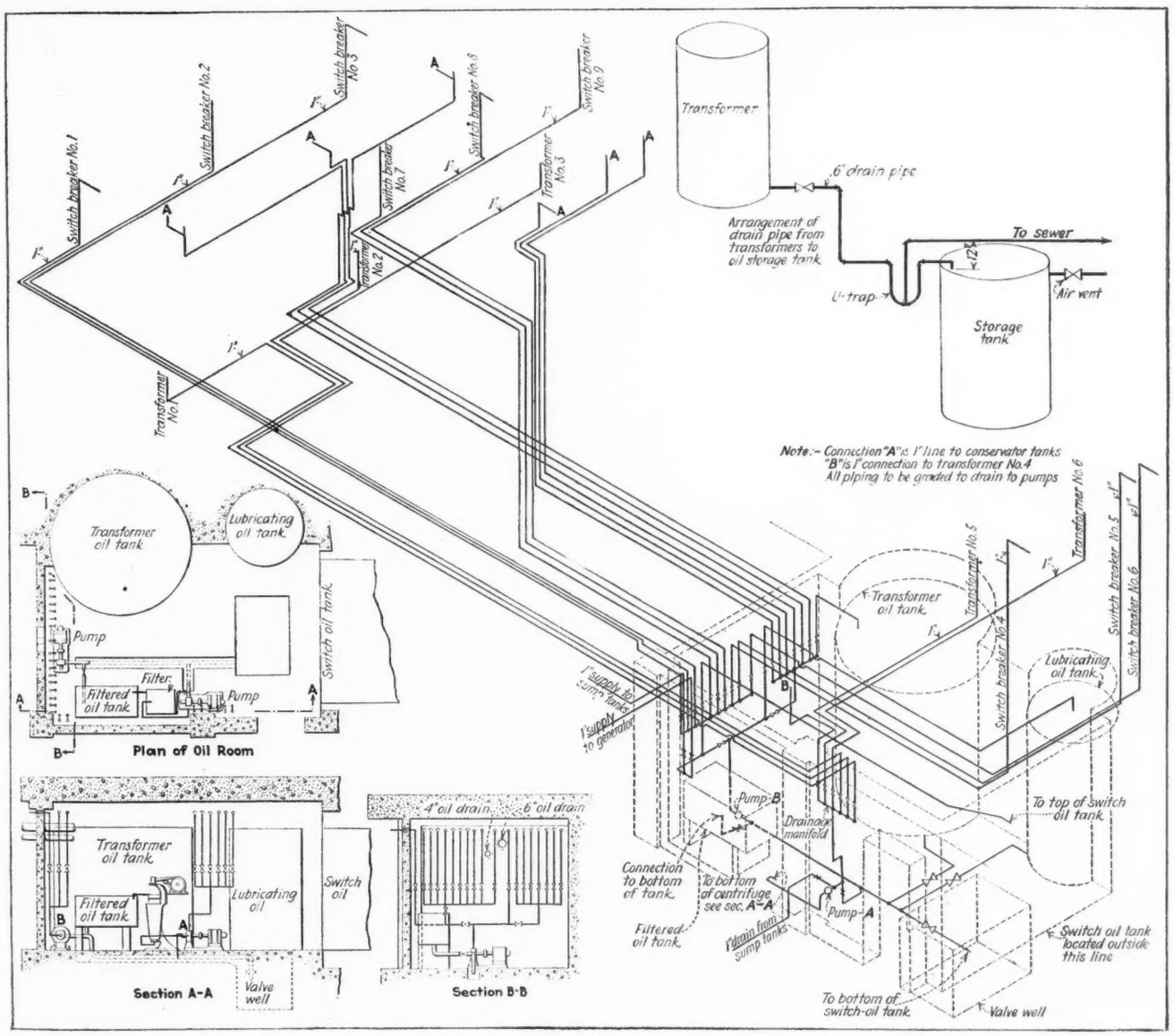



**Fig. 2—Diagram of piping and storage tank arrangement for handling and treating the transformer, switch and lubricating oils**

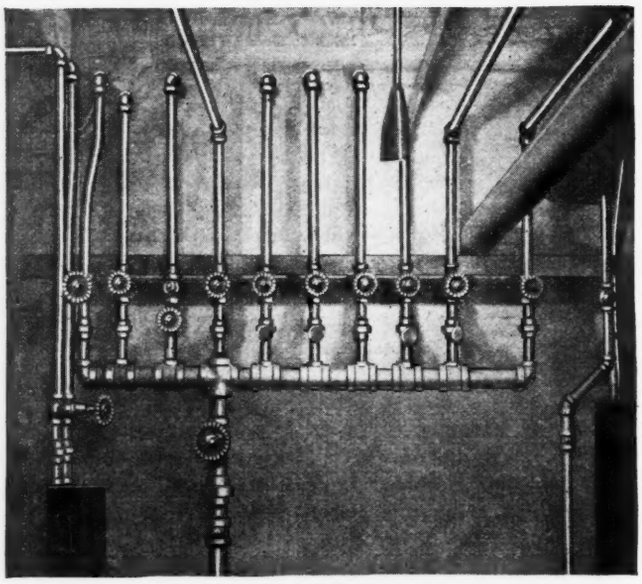


**Fig. 3—Outgoing manifold in the oil conditioning and storage room**

quart of oil is drained and inspected for globules of water before the sample to be tested is secured. This averts contamination of the oil by dirt and moisture around the sampling valve, as a collection of water in the pipe external to the equipment may be discovered. The dielectric strength of the oil is held at about 28,000 volts, and if found to be decreasing the oil is filtered and the source of contamination is located and corrected. Power transformers' oil is filtered every two years, and the oil breakers after about six operations (based on the operating experience at this plant). Schedules on auxiliary transformers indicate cleaning and filtering at five-year intervals. Generator oil switches are dismantled and cleaned yearly, or after three operations by relay.

The oil room, as it is called, contains three storage tanks: One for switch oil of 6,680 gal. capacity, one for transformer oil of 3,880 gal. capacity, and one for lubricating oil, which is also used for the governor system, having a capacity of 1,174 gal. There are two

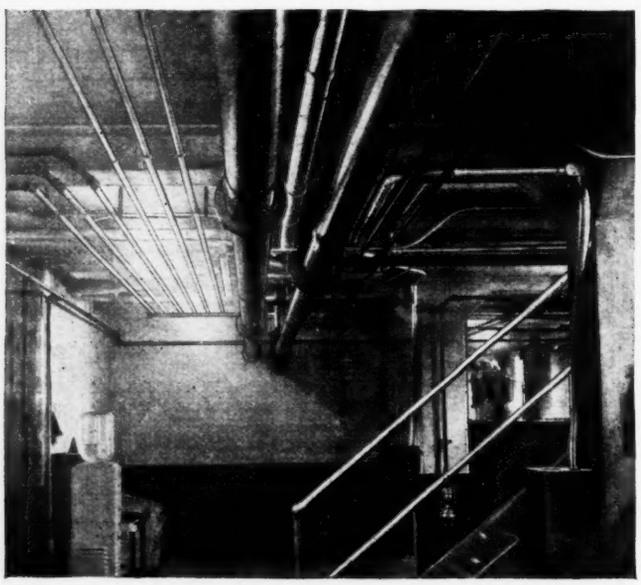


**Fig. 4—Plant basement, showing how the oil piping is carried on the ceiling**

motor-driven pumps in connection with the centrifuge and blotter press. One pump *A* delivers to the filter, and the other pump *B* delivers from the filtered-oil tank to a manifold that connects to individual pipes, each fitted with a valve leading to individual tanks of the circuit breakers and transformers. A small pipe leads from the bottom of each transformer and connects to the drainage manifold in the oil room, which permits direct connection to pump *A*. The large common drain line from the transformers enters the storage tanks as previously described. A common drain line connecting to all circuit breakers enters the storage tank and is circulated through the conditioning apparatus and back to the proper tank. Oil for transformers can be circulated for filtration without entering the storage tank. This is not true of the oil switches, as their oil must enter the storage tank before it can enter the pump leading to the filter. During repairs, the oil is stored in the tank and may be circulated locally for purification.

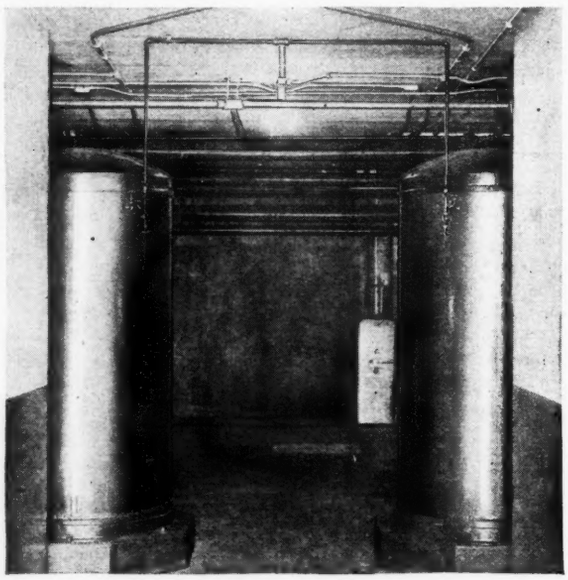


**Fig. 5—Pressure tanks for the governors with the oil piping above them**

Lubricating oil from the generator bearings may be circulated through the conditioning apparatus. Oil from the sump tanks of the governor system may be similarly handled.

In certain climates it is necessary to heat insulating oils to a temperature above the dew point to prevent condensation of moisture while in contact with air, and this temperature should be maintained while the oil is in the storage tanks.

✦

METERS FOR LIGHTNING—Natural lightning bolts are now being metered and measured by lightning investigators of the General Electric Company with a new device called the lightning stroke recorder. The instrument measures passing current and gives engineering some real facts with which to work. It is a device of porcelain containing sensitized film. It is placed in transmission towers, tall smoke stacks, and skyscrapers and furnishes a record from which can be determined the voltage of the stroke. The investigators found that an ordinary lightning stroke measured one hundred billion kilowatts. This staggering amount of energy is worth about $3 at the average rate for power today, for it was discharged in a matter of millionths of a second.

# . . . RIGHT OUT OF THE PLANT . . .

## Loosening Clinkers With Steam Jets

IN THE operation of the hand-fired and semi-automatic types of stokers burning Midwestern coals at high ratings it is necessary at intervals to remove the clinkers on the side walls with bars. This is a rather awkward process, owing to the inclination of the grates.

We have installed a series of steam jets under the grates of two 72-in. x 16-ft. horizontal return-tubular boilers and have not had to use a bar the past season. The jets, drilled in pipe, $\frac{1}{16}$-in. holes spaced 8 in. on centers, are placed under the bearer bars so that they discharge their steam under the clinkers. When clinkers form that cannot be removed by operating the grate we crack the valve leading to the jets until we can see steam coming through the fuel bed, and in ten or fifteen minutes a pull on the levers loosens up the clinkers.

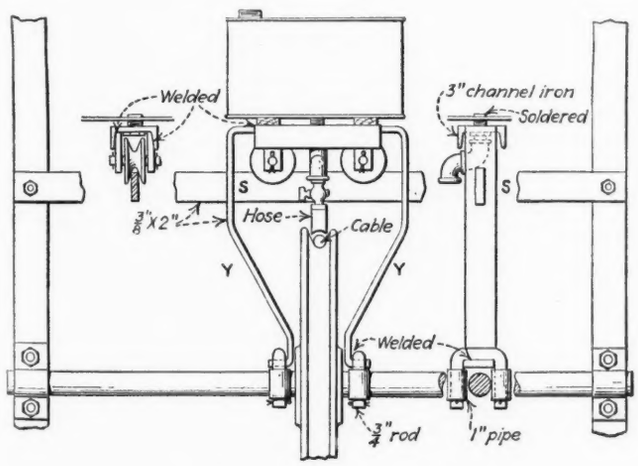
Beloit, Wis. S. W. STEARNS.

1.

## Cable-Oiling Device

THE accompanying illustration shows a cable-oiling device made by our plant maintenance man. Odds and ends found around the shop furnished the materials. The wheels are discarded trolley wheels and the tanks are discarded oil cans.

The oiler lubricates hoisting cables in a mine, the method being considered more advantageous than the




**Details of traveling cable oiler**

previous practice of applying cable grease, which was wasteful of both time and material. Black oil has been found to be satisfactorily penetrating. The supply is regulated by a pet-cock to which is fitted a nipple and piece of hose. The nipple is soldered to the bottom of the tank, which rests on two thin wooden wedges.

Located on the first pulley stands from the engine house, where the "whip" in the cables is practically nil, the oiler rides on a rail made from a piece of $2\frac{3}{8}$ in. flat iron guided by the sheave through the yoke *Y*, which is slotted at *S*, thus following the rail.

To prevent scraping of the axle, the yoke is fitted with two pieces of 1-in. pipe which roll against the axle.

The feed, of course, is adjusted according to the length of cable and the frequency in motion.

Ironton, Minn. AXEL LEKSTROM.

## Shift Schedules for Power Plant Operators

IN REFERENCE to the article by G. L. E. Linn on "Five- and Six-Day Week Schedules for Power Plant Operators," in *Power* of June 10, there is a method of shift change which Mr. Linn did not describe and which, being in satisfactory operation, might be of interest and use to plant operators.

During the year 1924 the plant of which I had charge, at that time employing three shift engineers and three firemen, one of each to an eight-hour shift, was put on a six-day week. As a relief man we hired an engineer to work half time as engineer and half time as fireman. After experimenting with various weekly schedules of shift change, somewhat the same as those described by Mr. Linn, and finding them not quite agreeable to all, we finally decided upon a rotative cycle of shift changes, in which each man of the seven works sixteen consecutive shifts of the same hours and then takes off 80 hr., returning to take the shift previous to that relinquished, that is, he moves back one shift. The relief man is paid the average of an engineer's and fireman's pay, and all are on a fixed monthly rate.

Schedule *A* presents the sixteen-shift cycle, *A*, *B*, and *C*, representing engineers, and *D*, *E*, and *F* representing firemen, *X* being the relief man. The complete cycle consumes 56 days, so that each man of the seven will in this period have worked his quota on all three shifts and will have had one-seventh of his gross time off. It will be seen that no notice is taken of Sundays or other special days, and that irrespective of when a man comes off shift he always stays out 80 continuous hours. Engineer *A*, for example, relinquishing the night, or 12-8, shift at 8 a.m. of day 6, as shown on the schedule, returns on day 9 at 4 p.m., and fireman *F*, relinquishing the 4-12 shift at midnight of day 8, returns to the fire

SCHEDULE "A"
16-Shift Cycle

| Day | 12-8 | | 8-4 | | 4-12 | |
|---|---|---|---|---|---|---|
| | A | D | B | E | C | F |
| | A | D | B | E | C | F |
| I | A | D | B | E | X | F |
| 2 | A | D | B | E | X | F |
| 3 | A | D | B | E | X | F |
| 4 | A | D | C | E | X | F |
| 5 | A | D | C | E | X | F |
| 6 | A | D | C | E | X | F |
| 7 | B | D | C | E | X | F |
| 8 | B | D | C | E | X | F |
| 9 | B | D | C | E | A | X |
| 10 | B | D | C | E | A | X |
| 11 | B | D | C | E | A | X |
| 12 | B | D | C | F | A | X |
| 13 | B | D | C | F | A | X |
| 14 | B | D | C | F | A | X |
| 15 | B | E | C | F | A | X |
| 16 | B | E | C | F | A | X |
| 17 | B | E | C | F | A | D |
| 18 | B | E | C | F | A | D |
| 19 | B | E | C | F | A | D |
| 20 | B | E | X | F | A | D |
| 21 | B | E | X | F | A | D |
| 22 | B | E | X | F | A | D |
| 23 | C | E | X | F | A | D |
| 24 | C | E | X | F | A | D |
| 25 | C | E | X | F | B | D |
| 26 | C | E | X | F | B | D |
| 27 | C | E | X | F | B | D |
| 28 | C | E | A | X | B | D |
| 29 | C | E | A | X | B | D |
| 30 | C | E | A | X | B | D |
| 31 | C | F | A | X | B | D |
| 32 | C | F | A | X | B | D |
| 33 | C | F | A | X | B | E |
| 34 | C | F | A | X | B | E |
| 35 | C | F | A | X | B | E |
| 36 | C | F | A | D | B | E |
| 37 | C | F | A | D | B | E |
| 38 | C | F | A | D | B | E |
| 39 | X | F | A | D | B | E |
| 40 | X | F | A | D | B | E |
| 41 | X | F | A | D | C | E |
| 42 | X | F | A | D | C | E |
| 43 | X | F | A | D | C | E |
| 44 | X | F | B | D | C | E |
| 45 | X | F | B | D | C | E |
| 46 | X | F | B | D | C | E |
| 47 | A | X | B | D | C | E |
| 48 | A | X | B | D | C | E |
| 49 | A | X | B | D | C | F |
| 50 | A | X | B | D | C | F |
| 51 | A | X | B | D | C | F |
| 52 | A | X | B | E | C | F |
| 53 | A | X | B | E | C | F |
| 54 | A | X | B | E | C | F |
| 55 | A | D | B | E | C | F |
| 56 | A | D | B | E | C | F |
| 57 | A | D | B | E | X | F |

SCHEDULE "B"
10-Shift Cycle

| Day | 12-8 | | 8-4 | | 4-12 | |
|---|---|---|---|---|---|---|
| | A | D | B | E | C | F |
| I | X | D | B | E | C | F |
| 2 | X | D | B | E | A | F |
| 3 | X | D | B | E | A | F |
| 4 | X | D | C | E | A | F |
| 5 | X | D | C | E | A | F |
| 6 | B | X | C | E | A | F |
| 7 | B | X | C | E | A | D |
| 8 | B | X | C | E | A | D |
| 9 | B | X | C | F | A | D |
| 10 | B | X | C | F | A | D |
| 11 | B | E | C | F | A | D |
| 12 | B | E | C | F | X | D |
| 13 | B | E | C | F | X | D |
| 14 | B | E | A | F | X | D |
| 15 | B | E | A | F | X | D |
| 16 | C | E | A | F | X | D |
| 17 | C | E | A | F | B | X |
| 18 | C | E | A | F | B | X |
| 19 | C | E | A | D | B | X |
| 20 | C | E | A | D | B | X |
| 21 | C | F | A | D | B | X |
| 22 | C | F | A | D | B | E |
| 23 | C | F | A | D | B | E |
| 24 | C | F | X | D | B | E |
| 25 | C | F | X | D | B | E |
| 26 | A | F | X | D | B | E |
| 27 | A | F | X | D | C | E |
| 28 | A | F | X | D | C | E |
| 29 | A | F | B | X | C | E |
| 30 | A | F | B | X | C | E |
| 31 | A | D | B | X | C | E |
| 32 | A | D | B | X | C | F |
| 33 | A | D | B | X | C | F |
| 34 | A | D | B | E | C | F |
| 35 | A | D | B | E | C | F |
| 36 | X | D | B | E | C | F |

**Schedule *A* gives a complete rotation every 56 days and schedule *B* every 35 days**

room at 8 a.m. on day 12. The relief man works eight consecutive shifts in the engine room and then moves over into the fire room for eight similar shifts.

Our reasons for adopting this shift schedule were: Every man of the seven gets exactly the same time off; there is no double shift or shift break required at intervals. The three continuous days "in a lump" gives each man reasonable time for recreation. The sixteen-shift period gives the night shift man better opportunity to adjust himself to change of sleeping time; there is no jealousy on the score of "who gets Sundays" or holidays; every man takes a regular equal turn on all three shifts, thus keeping him posted on the working of the plant at all times and bringing him, on the day shifts, under direct supervision of the chief engineer.

This arrangement has been in operation for over five years without an objection from anyone concerned.

With the same number of crew, or multiples thereof, a shorter cycle giving a work period of ten consecutive shifts and 56 hr. off is workable. This gives a complete rotation every 35 days, as shown in Schedule *B*. A yet shorter cycle in which each man works four consecutive shifts and then takes off 32 hr. can be used, giving a complete rotation every fourteen days. Such short cycle is, however, objectionable, in that the men never get settled, especially the night men. And due to its meshing closely with the normal weekly cycle of days it does not afford an equal distribution of Sundays off. In the longer shift cycles, which do not keep step with the normal week, each man of the seven gets about an equal share of Sundays off in the course of a year.

St. Paul, Minn. W. SPOFFORTH.

# Failures of Steam Engine Valve Chest Covers

A RECENT failure of a large steam engine valve chest cover calls attention to a danger in connection with compound steam engines, that of high-pressure steam passing into the low-pressure cylinder or into the receiver or pipes between the cylinders.

The valve chest of the high-pressure cylinder of a compound engine is designed to stand the boiler pressure, but the chest of the low-pressure cylinder is usually designed for a much lower pressure, around 35 to 40 per cent of the boiler pressure. It is clear that if high-pressure steam should enter the low-pressure valve chest there is serious risk of an explosion.

There are several ways in which excessive pressure may be produced in the low-pressure valve chest. It is possible for the danger to arise when the engine is being warmed up prior to starting. If, for example, both the ports of the low-pressure cylinder should be closed when the engine is being warmed up by high-pressure steam, pressure may gradually accumulate in the valve chest to a dangerous extent. This actually happened at a textile mill some time ago, and as a result a large cover 8 ft. long x 4 ft. wide was blown from the valve chest of the low-pressure cylinders.

Another way in which excessive pressure may be induced in the low-pressure valve chest is by failure of the high-pressure cylinder steam-admission valves to close when the engine is at work. Should this happen, high-pressure steam will pass into the first cylinder continuously, and if the exhaust valves operate normally, high-pressure steam will pass through to the low-pressure valve chest.

Failure of a high-pressure admission valve to close is usually caused through some fault in the dashpot. Excessive pressure in the low-pressure valve chest may also be brought about through the low-pressure cylinder admission valve's failure to open; steam rapidly accumulates in the chest, and the pressure quickly rises to a dangerous extent. A low-pressure admission valve may fail to open through the valve lever's breaking or because the key used for securing the lever to the valve spindle works loose and falls out of position.

Many cases of overpressure and consequent failure of low-pressure valve chests have been the result of increasing the working pressure with the object of increasing the power of the engine. The fact should not be lost sight of that an engine is designed, in the first place, for a certain initial pressure, and if a higher pressure be adopted the parts may be stressed to an unsafe amount unless they are suitably strengthened.

It will be seen that the possibility of high-pressure steam's entering the low-pressure valve chest of a com-

pound engine is not by any means a remote one, so it is essential that suitable provision be made to guard against the danger of explosion should this happen. The safest plan would, of course, be to design the receiver and the low-pressure valve chest and cylinder for the full boiler pressure, but this means greatly increased cost of construction.

As a safeguard against overpressure, the receiver or the pipes between the cylinders should be fitted with a safety valve of ample area. Too often, this valve is too small for its purpose, being incapable of relieving a sudden large increase in the volume of the steam. If a valve of large area is fitted, and maintained in good working order, the possibility of explosion from an overpressure will be slight.

The foregoing remarks have been confined to the compound or two-cylinder engine, but are applicable to three- and four-cylinder engines. The failure referred to occurred in connection with a triple-expansion engine fitted with corliss valves. The engine was running at its usual speed and under normal working conditions as regards boiler pressure, vacuum, etc., when the failure occurred. Without warning, a large portion of the intermediate cylinder valve chest cover was blown out with great violence. The low-pressure valve chest cover was also fractured. The explosion was caused by excessive pressure in the intermediate valve chest, but how this excessive pressure was brought about cannot be explained with certainty. It is stated to have been due to one of the high-pressure admission valve's failure to close, or to the steam valves' of the low-pressure cylinder becoming inoperative and remaining in the shut position. A safety valve was fitted to the intermediate valve chest cover, but it seems doubtful if this valve functioned at all.

Manchester, England. EDWARD INGRAM.

## Ammonia Leaks in a Brine Tank of a Refrigerating Plant

REFERRING to the reply in the July 15 issue of *Power* in regard to ammonia leaks in a brine tank, I should like to say that we recently had the same trouble in our refrigerating plant.

Through a leak in the coils we discharged probably 200 lb. of ammonia into the calcium brine and attempted to counteract this ammonia with muriatic acid, but were not successful. Within a week after ammonia was first discovered in the brine the brass rods of the brine pump had been attacked to such an extent that the pump had to be taken apart and the rods turned down. We immediately discarded the old brine containing the ammonia, since there were a number of brass valves on the brine line which in a short while would have been ruined.

So far as the galvanizing on the ice cans is concerned, we found a white powder-like formation, but to what extent or how serious the effect might be over a longer period it is hard to say.

I should be skeptical of continuing the use of calcium brine, saturated with ammonia, even though no brass were in use in the system, because the extreme alkaline condition caused by the ammonia would promote corrosion even though there was no actual chemical reaction from the ammonia itself.

R. M. ROTHGEB, *Plant Engineer,*
Raleigh, N. C. State Hospital at Raleigh.

## What Recirculation Accomplishes

IN THE July 22 number an article by J. D. Yoder entitled "What Recirculation Accomplishes" points out several items that are open to argument in a former article by P. M. Contant.

In one plant with which I was connected we did some experimenting on this score and found out many things that bear up Mr. Contant. While the value of recirculation depends chiefly on the condition of the make-up water (as Mr. Yoder mentions), at the same time his statement that the raw water requires more than 53.5 parts per million to build up the sulphate ratio seems incorrect unless there are other things to be considered.

For example, in a plant using a zeolite softener and recirculating ahead of the softener, all of the boiler blow-off would naturally build up sulphate in the boiler, regardless of the parts per million the original make-up water contained. The sulphates go through the reaction chamber, where recirculated blow-off is injected into the make-up, and also will go through the zeolite bed, so I fail to see what could keep them from building up in the boiler (providing, of course, the boiler was never blown to waste).

Mr. Yoder, in the next to the last paragraph, also mentions that with recirculation two controls would be necessary, which complicates the problem. This also depends on the layout of the plant. As a matter of fact, in a plant equipped with zeolite softeners and having either one or more boilers, the sulphates, carbonates, and hydrates can be controlled in any boiler with less trouble than is given by the simplest hot-process softener.

Still another instance he mentions, that a boiler water may not necessarily be soft when an excess of sodium may all be in the bicarbonate form, is, of course, true, but the quantity of hydrate (when recirculation is used with the zeolite system) can be controlled to a nicety, and, therefore, the hardness. By excess recirculation it is of course possible to get a bicarbonate water in the boiler, or one can go still further and get a distinctly acid water, which will color the water red in less than an hour on full rating. However, these conditions are easily foreseen by simple titration of the water daily, and are not likely to occur, except where done purposefully for experiment.

With recirculation in conjunction with a zeolite system, the sulphate can be quickly brought down by letting the blowdown water from the deconcentrator go to waste. The hydrates can be reduced by increasing the rate of recirculation, that is, the number of gallons per minute injected into the raw water make-up ahead of the zeolite.

It is a common assumption that where raw water make-up is low in sulphates a zeolite softening plant is the wrong kind of an installation. We have found out by experiment that such is not the case. In fact, that is just the condition where it is of the most value, for the reason that no chemicals must be purchased except a small amount of salt. This latter cost is almost negligible, for in recirculating ahead of the zeolite bed practically all the magnesium is precipitated out and screened off on the top of the sand filter, thus lessening the work that the zeolite has to do. A goodly portion of the calcium is also removed, so a charge of salt will last much longer than is ordinarily the case without recirculation. The lower the carbonates and hydrates in the boiler the more pronounced this becomes.

Waterloo, Iowa. JOHN A. MORRIS.

# From Among Readers' Problems

*Conducted by*
**L. H. MORRISON**

BOILER EFFICIENCY—*We ran a boiler test, obtaining the following data: Steam pressure, 100 lb. gage; moisture, 4 per cent; feed-water temperature, 132 deg. F.; water evaporated, 40,000 lb.; coal used, 4,000 lb.; heat value of coal, 13,990 B.t.u. per pound.*

*How is the efficiency found?* C.A.B.

This is evidently an examination question, as it has been asked several times by readers of *Power*. The total heat in a pound of dry saturated steam can be separated into two parts, the heat of the liquid and the latent heat of evaporation.

At 100-lb. gage, 115-lb. abs., each pound of water at the corresponding temperature of 338 deg. F. contains 309 B.t.u., measured from water at 32 deg. F. If the pound had been evaporated into dry steam there would have been added 879.8 B.t.u. more, but as there was 4 per cent moisture in the steam, obviously only 96 per cent of each pound was evaporated, or each pound had added to it $\frac{96}{100} \times 879.8 =$ 844.6 B.t.u. The total heat in each pound of the mixture was then 309 + 844.6 = 1,153.6 B.t.u. But the feed water at 132 deg. F. had in it 99.9 B.t.u. per pound, as measured from 32 deg. F. The net heat absorbed from the furnace per pound of water was then 1,153.6 — 99.9 = 1,053.7 B.t.u., and 40,000 lb. would have absorbed 42,148,000 B.t.u.

The coal contained 4,000 × 13,990 = 55,960,000 B.t.u., so the boiler efficiency was $\frac{42,148,000}{55,960,000} = 75.3$ per cent.

CAUSE OF CRACKED ICE—*What causes our ice to crack? Until this summer we never had this trouble.* C.S.

If the ice cracks while in the cans in the brine, the difficulty may be caused by too low a temperature of the brine in the tank. The lower brine temperature makes the freezing time much shorter, so that the ice may be weaker and more likely to develop fracture of the crystals. Also, an unevenness of the temperature of the brine may cause the ice to develop cracks. Agitation of the brine may not be uniform, or the ammonia may be fed to the coils so that a layer of cold brine is formed at the top of the tank, which may cause the cakes to freeze at the top first. Putting high-temperature water into the cans has been known to produce cracking of the ice.

By reducing the temperature of the water, the cracking may be eliminated. Uneven pulling of the ice may produce temperature changes that are harmful.

Likewise, presence of foreign matter in the water has been known to cause cracking. The water may contain solids and gases in solution, which in some manner will cause the cakes to develop cracks. The water may not be properly reboiled, or it may contain brine, other solids, or gases, which affect the formation of the crystals so that cracking develops.

If the ice cracks after having been withdrawn from the tank, it may be caused by several factors. Warm draughts of air may be allowed to strike the cold ice cans, or they may be placed in the thawing water too soon after being withdrawn from the cold brine. The blocks, therefore, should be properly "tempered" before they are put into the thawing water. Also cracks may develop if the thawing water is too warm.

FINDING INDICATED HORSEPOWER OF A DIESEL—*How is it possible to find the indicated horsepower of one cylinder of a six-cylinder Diesel engine?* C.V.M.

Indicator diagrams from Diesel engines are small in proportion to the work the area represented, due to the spring scale.

It is possible to determine the indicated horsepower of one cylinder by loading the engine with all cylinders firing. One cylinder is then cut out and the speed brought back to normal by adjusting the load. The difference in the load reading at constant speed is then the indicated horsepower of the one cylinder.

# PREVIOUS QUESTION

## *Discussed by Readers*

### THE QUESTION

*WE HAVE opportunity to purchase a second-hand 250-hp. engine for $1,050. The seller states that the full-load steam consumption is 30 lb. per brake horsepower-hour. A new engine-generator unit would cost $12,000, but the steam consumption would be only 20 lb. per brake horsepower-hour. If steam costs 40c. per 1,000 lb. and the engine will run 2,000 hr. per year, which is the better purchase?* C.P.M.

SINCE the problem is not fully stated, I shall assume that the second-hand machine is an engine-generator set with a useful life of about fifteen years; that the new machine has a life of 30 years; that the current rate of interest is 6 per cent; and that the machines are to be run at full load throughout the year.

Using vestances as a basis of comparison, $V_d$, the depreciation vestance for the new equipment, or the total of the present worth of investment and reinvestment, would equal the initial cost divided by $[1 - 1/(1 + R)^n]$, where $R$ = interest rate and $n$ = life of machine. Therefore, $V_d = 12,000 \div [1 - 1/(1 + 0.06)^{30}] = \$14,530$.

The operating costs per year of the new equipment would be $20 \times 250 \times 2,000 \times 0.40 \div 1,000 = \$4,000$. Operating vestance, or the money required to earn operating costs, at 6 per cent interest = \$4,000/0.06 = \$66,667.

Total vestance for new machine = depreciation vestance + operating vestance, or \$14,530 + \$66,667 = \$81,197.

Depreciation vestance for the second-hand machine would be $1,050 \div [1 - 1/(1 + 0.06)^{15}] = \$1,800$.

Operating costs of the second-hand equipment would be

$$\frac{30 \times 250 \times 2,000 \times .40}{1,000} = \$6,000 \text{ per year}$$

The operating vestance would be

6,000/0.06 = $100,000, making the total vestance for the second-hand machine $1,800 + $100,000 = $101,800.

Although the initial cost of the second-hand machine is much less than that of the new equipment, the difference in steam consumption would be enough to make the latter the better investment.

E. D. PARMER,
University of Texas.
Port Arthur, Texas.

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IN ALL PROBABILITY the installation of the new engine-generator unit at a cost of $12,000 would incur a lower yearly total expense than the installation of the second-hand engine, and therefore its purchase is justified. Only under the condition that the exhaust steam could be used for heating or process would the second-hand unit show a lower yearly total expense.

Considering all the items that would enter into the installed cost of both units, the new engine-generator unit would amount to approximately $16,300 installed, and the second-hand engine would amount to about $6,750 installed. The installation cost of the second-hand unit is higher than the new unit, because a generator would have to be purchased in addition to the engine and the erection cost for the two would be slightly higher than for the single engine-generator unit. It has been estimated that the cost of a second-hand generator with the necessary belt to connect to the second-hand engine is about $1,100.

The yearly total expense may be grouped into four items, of fixed charges, maintenance, fuel cost, and labor. Labor would be the same for both units and can be neglected in the comparison. Fixed charges, such as interest, depreciation, taxes, and insurance are assumed to be 15 per cent for the new unit and 17 per cent for the second-hand unit. The extra 2 per cent is justified on the basis of higher depreciation for the second-hand unit. Maintenance would undoubtedly be higher for a belted unit than a direct-connected unit, and it is assumed at $700 for the second-hand engine and $500 for the new engine-generator. The total yearly fixed charges plus maintenance will therefore be:

$1,148 + $700 = $1,848 for the second-hand unit, and
$2,445 + $500 = $2,945 for the new unit

The difference of approximately $1,100 is in favor of the second-hand unit, but in all probability this will be offset by the greater cost of steam to drive the engine.

Assuming an average power load for the 2,000 operating hr. of 140 kw., this will be found equal to 221 b.hp. for the second-hand unit and 203 b.hp. for the engine-generator unit. The difference is required because of belt losses and lower generator efficiency. Average steam consumption of the second-hand unit would therefore be 6,630 lb. per hour, costing $5,300. The new unit would require only an average of 4,060 lb. of steam per hour, and the corresponding yearly cost would equal $3,250. This shows an operating saving of $2,050 for the new unit and a net saving in yearly total expense of $950.

HAROLD LUTHER SMITH.
*Consulting Engineer.*
Buffalo, N. Y.

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THE QUESTION does not state whether the exhaust steam from the engine is used in any way; hence it is assumed that at least 2,500 lb. of exhaust steam per hour will be wasted if the second-hand engine is purchased.

Cost of additional steam consumed by the second-hand engine will be $2,000 per year, and the additional cost of the new engine, over and above the cost of the second-hand engine, will be $10,950, since it is reasonable to assume that the cost of installing either engine will be about the same.

At the end of eight years the total fuel savings will be $16,000. Interest, taxes, and insurance on the additional investment will amount to about 10 per cent, which on an investment of $10,950, decreased at the rate of $1,368.75 per year for eight years, is $4,927.50. This amount added to the $10,950 shows that the sum of the additional investment and the investment charges at the end of eight years will be $15,877.50, which is $122.50 less than the savings over the same period.

Hence, considering fuel savings alone, it is evident that in slightly less than eight years savings due to the purchase of the new engine will return to the purchaser the difference in cost between the new engine and the second-hand engine, and pay all investment charges on this difference during that time. Therefore, if the exhaust steam is to be wasted, the new engine is a better purchase, unless the expected life of the plant in which it is to be installed is less than eight years.

In the foregoing, maintenance costs have not been taken into account. But it is reasonable to assume that maintenance on the new engine will be less than that on the second-hand engine. This will, of course, increase the savings and the desirability of purchasing the new engine.

If all the exhaust steam were to be used, the second-hand engine would be the better purchase, since there would be more heat per pound of steam in the exhaust of the second-hand engine, and because the steam saved by the new engine would have to be replaced by live steam passed through a reducing valve, or exhaust steam from other units. If a portion of the exhaust steam saved by the new engine could be used, the advisability of purchasing the new engine would depend on the amount of exhaust steam wasted, and the expected life of the plant.

C. A. BUTLER, JR.
Kansas City, Mo.

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FOR THE purpose of the comparison called for and in the absence of other information, it is assumed that in the first case the engine would drive its plant either direct or through belts, ropes or gearing, dependent upon the present layout arrangement. Otherwise to make an equitable comparison an additional sum would have to be added to the price of the second-hand engine to cover a generator, which is apparently included in the price of the new unit.

The incidentals necessary to make a fair comparison are, interest and depreciation on capital cost, cost of steam, cost of repairs and spares, and would be as follows:

| $12,000 NEW ENGINE-GENERATOR UNIT | |
|---|---|
| Interest, 5 per cent | $600 |
| Depreciation, 7½ per cent | 900 |
| Steam (10,000,000 lb.) | 4,000 |
| Repairs and spares | 250 |
| | $5,750 |

| SECOND-HAND ENGINE | |
|---|---|
| Interest, 5 per cent | $52.50 |
| Depreciation, 15 per cent | 157.50 |
| Steam (15,000,000 lb.) | 6,000 |
| Repairs, etc. | 500 |
| | $6,710.00 |

It is obvious that on the score of cost of steam only the better purchase would be that of the new plant, showing an annual saving over the second-hand engine of 14 to 15 per cent, despite the fact that a moderate sum has been allowed for depreciation, repairs and spares in the case of the second-hand engine, which figures would to some extent depend upon the age and condition of the engine.

A further consideration, not taken into account in the above comparison and which would operate in favor of the new unit, is that of boiler capacity and the amount of coal to be handled for stoking purposes.

In the event of hand stoking it might be necessary to engage additional attendance for the second-hand plant, because, assuming it to be customary for one attendant to fire the boiler and run the engine under normally efficient conditions, there would be 50 per cent additional coal to fire for the second-hand plant, with its contingent freight and handling charges.

O. P. STEGGALL,
*Capt. R. E. (T),*
*A. M. I. Mech. E.*
Leeds, England.

## A Question for Our Readers

*OUR plant, containing two 4,250-sq.ft. 300-lb. boilers, is now served by one centrifugal boiler feed pump. We feel that a stand-by should be provided. Should this be a centrifugal, a steam-driven duplex or an injector?*

C.A.R.

Suitable answers from readers will be paid for and published in the Sept. 30 number

# *Suitability of Steam Turbines for Large Load Range*

**Excerpts from a paper by Sir Charles A. Parsons before the World Power Conference in Berlin**

FOR a given vacuum and an assumed leaving loss, maximum output that can be obtained from a steam turbine at any given speed depends, ultimately, on the tensile strength of the material used for the parts subjected to the maximum stresses. If the output of a constant-speed turbine is required to be extended far beyond the economical, this can be done without increasing the maximum stresses, which are mainly due to centrifugal forces.

Steam pressure and dynamic forces upon nozzles and blading can always be supported by making the latter robust enough, and the torsion in the shaft ends and couplings is readily maintained within safe limits. Larger steam chests and possibly larger steam pipes will be required, but there is no fundamental difficulty in this. Flexibility in steam lines is now attainable by the use of corrugated steel pipes while in proportion as steam pressures are increased, although of greater thickness, the size of these pipes will be reduced.

Economy of steam over the desired range of working, on either side of the most economical load, is obtained by suitably proportioning the blading and by the use of nozzle or bypass control or both.

In a turbine commencing with a velocity wheel with one or more rows of blades, the range of load can be met by nozzle control, that is, by opening up more nozzles and by bypassing stages when the highest loads are required.

In pure reaction turbines a portion of the blading at the high-pressure end, designed to prevent undue throttling at the governor valve on half economical load, can be cut out altogether at the economical load by means of a bypass valve. Here again the object of the control is to prevent as far as possible reduction of the available heat drop, for although the efficiency ratio (reckoned on the initial pressure at the blading) is about the same at the economical load as at the half load, loss at inlet by throttling occurs if the initial pressure at the blading is permitted to drop. Higher loads can be met by providing additional bypass valves.

With either arrangement there is a certain load, namely, the "economical load," for which the turbine has been designed and beyond which the economy begins to decrease, mainly on account of the reduction of the total available heat drop. This reduction however, now takes place at the other end of the expansion and is due to falling vacuum. Attempts to prevent this loss of vacuum during overloads are not of much avail, for at constant vacuum and increasing overload the leaving loss goes up rapidly (as the square of the volume of steam passing through the final stage), so that the available heat drop is inevitably sacrificed in any case.

As regards the efficiency of the blading itself over a range of load beyond the economical, this does not alter very much, for the velocity ratio, upon which the efficiency mainly depends, is not much affected, except at the exhaust end. That this is so may be seen by consideration of the fact that in a modern compound turbine the steam pressure $p$ at any stage is given approximately by the relation:

$$p^2 = p_o^2 + R^2 Q^2$$

where $p_o$ is the final exhaust pressure, $Q$ the quantity of steam passed per unit time and $R$ a coefficient depending on the proportions of the blading beyond the stage considered and also inversely proportional to the square root of the homogeneous head $p_v$.

In a condensing turbine $p_o^2$, the square of the final exhaust pressure, is a negligible quantity compared with the respective squares of the pressures higher up the turbines, so that it is permissible to write $p = RQ$.

The velocity ratio $\frac{U}{C}$ is inversely proportional to the volume of of steam $Q_v$ passed in unit time, and this leads to the result that

$$\frac{U}{C} = \frac{\lambda}{\sqrt{p_v}}$$ in which $\lambda$ is a coefficient appropriate to the blading in question. The homogenous head $p_v$ for steam is nearly proportional to the absolute temperature, and as the distribution of temperature along the several stages of the turbine is not altered very widely by bypassing, it follows that the velocity ratio $\frac{U}{C}$ remains largely unaltered.

At the exhaust end of the blading, where $p_o$ becomes a large percentage of $p$, the velocity ratio will tend to decrease, but inasmuch as the vacuum is falling the efficiency of the final stages will not alter much, while the leaving loss increases but slightly.

It will thus be concluded that a turbine designed to give a range of operation greatly in excess of the economical load and involving no radical changes in design or unduly augmented capital expenditure can operate without reduction of efficiency other than that due to the change of vacuum. In other words, at a small increase in cost a turbine may be designed to operate with a flat characteristic over a wide range of duty.

As regards the condensing plant, it may be in some special instances found advisable to fit a larger condenser, although if the condenser is designed to give the normal vacuum up to the economical load and the circulating pump and pipes are designed accordingly, the vacuum on maximum load will fall only by about 1 in. of mercury, corresponding to an increase in steam consumption of 5 or 6 per cent. The condensate extraction pump will require to be increased in capacity and the air ejector to deal with more air, but these are small items.

If there are to be feed-water heaters in the feed system, these will have to be designed for the increased water capacity without putting too great a head on the feed pumps, but within reasonable limits an increased water velocity through the heaters will be advantageous in so far as it improves the rate of heat transmission. Hence the maximum rate of condensation $Q/S$ of the heating system, per square foot of heating surface, may be slightly increased while the ratio $S/A$ of heating surface to cross-sectional area of water flow may require to be slightly reduced. With these arrangements a feed-water temperature will be attained at the maximum load rather higher than that at the economical load. The probability is that it would be considerably higher on account of the increased steam pressure at the several points of tap-off.

Considering the heat-rate characteristic of the plant as distinct from the steam rate, the former will be proportionally even flatter than the latter, assuming stage feed heating is adopted. This is not on account of the higher final feed-water temperature alone, but is also due to the fact that the principal loss of available heat, caused by drop in vacuum, is incident on only about 75 per cent of the steam entering the turbine. Further, the reduced exhaust vacuum on overload leads to hotter condensate, while in addition the power for the turbine auxiliaries remains nearly the same and so becomes a smaller percentage of the total power generated.

The main problem lies in the design of the alternators suitable for an increase of capacity from 25 per cent to

75 per cent above normal, that is, an increase of 40 per cent on the usual continuous maximum rating.

A modern turbine-alternator will, at the usual maximum rating, attain practically its full temperature rise in about two hours. Since the duration of the peak loads on the system is usually a similar period, it is evident that for the proposed increased rating the alternator must be modified to be capable of that increase.

The problem must be solved in such a way that the increased rating is achieved without unduly increasing the capital cost per kilowatt installed or reducing the efficiency at normal loads.

Several possible alternatives suggest themselves, but since the main limitation to the output of an alternator is the permissible maximum temperature of the windings, the most suitable scheme would appear to be one in which the cooling of the windings is artificially increased during the emergency peak load periods. One method of doing this would be to increase the volume and velocity of the ventilating air supplied to the alternator. This proposal however, offers in practice but little advantage, for at the higher ratings a large proportion of the heat gradient is situated in the insulation of the conductors and in the iron of the stator core. This gradient would remain practically unaltered by an increase in the quantity of cooling air supplied.

A system of cooling which possess the most possibilities from a practical point of view would be that in which air ventilation in a closed system is adopted in the usual manner, but in which additional air coolers are provided and supplied with artificially cooled water.

The artificial depression of the temperature of the air at the inlet to the alternator could readily be effected by the use of a refrigerating machine. By such means it would be possible to store efficient cold brine in a tank for use in cooling the ventilating air down to 5 deg. C. throughout the emergency peak load periods.

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# Record-Breaking Turbine-Generators for Brooklyn Central Station

TWO TURBINE-GENERATORS that will set several records for capacity and size are being constructed by the General Electric Company for installation in the Hudson Avenue station of the Brooklyn Edison Company. One will be installed in September, 1931, and the other in April, 1932.

Each turbine will be of tandem-compound construction, with double flow in the low-pressure cylinder, and will drive a single generator of 160,000 kw. capacity at 0.8 power factor, with a maximum output of 200,000 kva. The single-shaft units operating in the East River station of the New York Edison Co. are rated at 160,000 kva. The unit is, therefore, the largest single-shaft machine operating at 1,800 r.p.m. Without auxiliaries or attachments the combined weight of each turbine and generator will be more than 1,000 tons. The turbines are designed for steam conditions of 400 lb. gage pressure, 730 deg. F. total temperature, and 1 in. abs. back pressure. Provision is made for bleeding steam at two stages for heating the feed water to a temperature of 270 deg. F. The compactness of the unit is shown by the fact that an output of almost 100 kva. will be obtained from one square foot of floor area.

Steam is to be admitted to the turbine through five control valves opening in sequence, which will result in a very flat load curve and high economy at part loads. The turbine will operate from half to full load with a change in efficiency of less than 2 per cent. The steam will exhaust from the high-pressure element into the double-flow low-pressure element through two cross-over pipes which have a total cross-sectional area of 46 sq.ft. The large buckets of the last stage will have a tip velocity of approximately 13½ miles a minute.

When the turbine is operating at full load it will require approximately 800 tons of steam per hour. This steam is to be delivered to the turbine through two lines 22 in. in diameter.

The generator will be rated at 160,000 kw., 16,500 volts and 7,000 amp. It will operate at 1,800 r.p.m. Cooling air will be forced through the generators by four motor-driven blowers inclosed in a separate structure on top of the generator stator. All four blowers will force 220,000 cu.ft. of air per minute through the generator; at light loads less cooling air is required, and some of the blowers may be shut down. The losses in the generator which appear as heat in the circulating air will be recovered by passing the circulating air through surface coolers through which the condensate will be circulated. The air coolers are to be placed above the turbine room floor, two on each side of, and integral with, the generator. Auxiliary coolers will be installed for use when necessary, employing sea water as a cooling medium.

The steel portion of the revolving field will weigh approximately 185,000 lb., and about 18 tons of copper strip will be required for the field winding. A special railway car will be required to ship the rotor, which will have a net weight of almost 150 tons.

The stator for the generator is so large and heavy that it exceeds both in dimensions and in weight railroad shipping limitations. The stator frame will therefore be made in halves, and these halves will be joined at the power station. The core, consisting of more than 150 tons of silicon steel punchings, will then be assembled, after which the armature windings will be installed in the armature core. The windings are not to be special in any respect except as to dimensions.

The new 160,000-kw. turbine-generators represent an outstanding achievement, since each single-shaft unit, with its single generator, will occupy in the power station a portion of the turbine room originally intended to accommodate 50,000-kw. equipment.

## Central-Station Output Up 6.6 Per Cent

OUTPUT of public utility central stations for the twelve months ended May 31, 1930, was 91,932,807,000 kw.-hr., according to figures just released by the statistical research department of the National Electric Light Association. Compared with 86,247,369,000 kw.-hr. for the corresponding period of 1928-29, this represents an increase of 6.6 per cent.

Of this output 35.3 per cent was generated by water power in the 1929-30 period and 38.6 per cent during 1928-29. For the power generated by steam, the average pounds of coal per kilowatt-hour was 1.64 in 1929-30 compared with 1.7 in 1928-29, a decrease in coal consumption of 3.5 per cent. Average revenue per kilowatt-hour was 6.07c. in 1929-30 and 6.37c. in 1928-29, a decrease of 4.7 per cent.

The value of plant and equipment installed in utility light and power plants on May 31, 1930, was $11,250,000,000. Total generating capacity of these stations on that date was 30,093,000 kw., of which 22,156,000 kw. was in steam, 7,553,000 kw. in water power, and 384,000 kw. in internal-combustion engines.

## Steam Engine Exports Drop in First Half of 1930

UNITED STATES EXPORTS of industrial machinery during June, 1930, were practically the same, by value, as those for June, 1929, but for the half year reached a total value of $132,125,000, or $6,300,000 more than for the corresponding period of 1929, according to reports just issued by the Department of Commerce. Construction, oil-well and oil-refinery, and metal-working machinery were most active and made substantial gains which more than offset losses in certain other classes.

Steam engines (other than locomotives) and textile machinery were notable exceptions to the upward export trend. Based on the half year comparison, exports of textile machinery fell off 31 per cent and steam engines (other than locomotives) nearly 24 per cent. Each of these classes also suffered sharp declines during June, as compared with June, 1929.

# *Results of Field Tests on Suggested Diesel Fuel-Oil Specifications*

## Progress Report No. 3 of the A.S.M.E. Special Research Committee on Diesel Fuel-Oil Specifications*

DURING the winter meeting of the American Society of Mechanical Engineers in New York, this committee presented a progress report. This report was mostly upon the results of various tests conducted by Diesel engine manufacturers on the fuel designated as tentative standard specifications. It will be remembered that a great many of these tests showed unsatisfactory operation by a number of the engines when operating on the oil specified for heavy-duty engines with a maximum viscosity of 200 seconds.

In most cases, in meeting the viscosity specification, the various oil companies had a Conradson carbon content in excess of the suggested maximum of 4 per cent, and the difficulties encountered in operating these engines were due to carbon formation, incomplete combustion, and erratic operation, especially at low load. Consequently the committee should turn its attention to the question of Conradson carbon and fluidity. If, as was pointed out in the second progress report, Conradson carbon in excess of the maximum could be employed and the oils be reduced in viscosity by applying heat to give the necessary fluidity, it is felt that satisfactory operation might be had. If the results are not as expected and the operation is unsatisfactory with the fluid oil, then the logical step will be to lower the Conradson carbon. The oil men on the committee have advised that if such a procedure is necessary, the viscosity will automatically be decreased and the general characteristics of the oil will all be improved, with the natural result of a more expensive oil to the consumer. Naturally it is the desire of this committee to standardize on the cheapest satisfactory oil available.

The committee requested the industry, through the medium of its last report, to conduct tests. In answer to this it received some very interesting data from the Florida Power & Light Company, in which that company stated that it had conducted some tests and had successfully burned fuel oil with a viscosity of 116 sec. at 122 deg. F. (Saybolt furol), which is approximately six times the viscosity recommended by this committee on the Universal scale. This oil has a Conradson carbon content of 10.07 per cent and about 15 gravity. It has been found that the oil could be satisfactorily burned in continuous operation with an average load factor of approximately 90 per cent when a temperature of approximately 125 deg. F. is maintained at the fuel-injection valve. Of course, this engine is a large and slow-moving two-cycle air-injection type.

On the other hand, a report has been passed on to this committee in which a 17 x 24 four-cycle solid-injection engine turning at 231 r.p.m. successfully handled 12 to 14 A.P.I. boiler oil. The oil is heated to approximately 200 deg. F. and flows through a jacketed line to the pumps. The report states that the engine can be operated from no load to 30 per cent overload and the exhaust be practically invisible. An inspection showed no evidence of carbon formation, and the exhaust valve remained in service the length of time equivalent to operation on light fuels.

One manufacturer has reported to the committee that his engine would not operate satisfactorily on the A.S.M.E. Diesel fuel. Consequently, he has redesigned his fuel system and now reports that this type of engine will successfully operate on fuels of this nature, with the following reservations:

1. Provisions be made to preheat the fuel to approximately 150 deg. F.
2. Provisions be made to start and stop the engine on a lighter approved fuel.
3. That the engine is not required to run at light loads, 25 per cent or less, for extended periods.

The oil supplied this manufacturer had a viscosity of 200 sec. and a Conradson carbon content of 5.17 per cent; but in concluding his report he writes as follows:

"From the foregoing it can readily be seen that we need a fuel oil of lower viscosity that will not require special means of heating between supply and nozzle and which can be used for cold starting."

Still another manufacturer of solid-injection engines reports that after having conducted tests on a fuel of 175 sec. viscosity and Conradson of 3.9 per cent, the exhaust at full load was smoky, with high gas temperatures, while at three-quarter and one-half loads the exhaust was clear, with normal temperatures. The following quotation more or less substantiates the committee's opinion that the manufacturers of Diesel engines can do much along the lines of design in making this fuel successful.

"All of this is due, no doubt, to the fact that our injection nozzle did not handle the heavier fuel in such a manner as to give the proper atomization and penetration. The test, however, did not result in any carbon deposits on the heads and pistons. Inspection after running on this fuel showed all working parts and filters to be clean.

"Our observations are that while the engine is capable of handling the fuel, we do not consider this oil as a satisfactory product for normal operation."

### Committee Has But Two Alternatives

The same condition exists as when the committee published its previous results. There is inconsistency in the operation of these various engines, and there seem to be but the two alternative plans. One is that the manufacturers of Diesel engines redesign their fuel system and install preheating equipment; but this is practically eliminated, as most of these concerns that have conducted tests have made it plain that they do not wish to operate engines in the field on an oil of these characteristics, and but one manufacturer has shown any desire to reconstruct his motor so that it will satisfactorily burn these fuels. Consequently, but the one alternative is left to the committee, and that is to improve the quality of the oil by lowering the viscosity and, simultaneously, the Conradson carbon, which will materially increase the price differential between steam-generating oils and Diesel fuel. Comments would be welcomed from the industry upon such a move by this committee.

### Light High-Speed Diesel Tests

One of the members of the committee, a manufacturer of this type of Diesel engine, has conducted a series of interesting tests on a small four-cycle four-cylinder 7 × 8½ solid-injection 80-hp. Diesel engine operating at 650 r.p.m. The first oil was a product of 44 viscosity, Saybolt Universal at 100, and a Conradson carbon of 0.48 per cent. The rest of the analysis indicated a distillate fuel. The exhaust was clear, and fuel consumption was normal through full load to half load. The engine was started cold. Comment by the test engineer was that the fuel was considered fairly satisfactory.

The next sample was 48 viscosity, Saybolt Universal at 100 deg. F. and Conradson of 1.6 per cent. The exhaust showed a trace of smoke. Fuel consumption was above normal.

The third test was on a fuel of 73

*Presented at the meeting of the Oil and Gas Power Division at Pennsylvania State College, State College, Pa., June 12, 1930.

## The Fuel-Oil Research Committee

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W. H. BUTLER, *Secretary*, Standard Oil Co. of New Jersey, New York, N. Y.
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R. MILLER, Chief Engineer, Oil Engine Department, Ingersoll-Rand Co., Phillipsburg, N. J.
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L. SCHNEITTER, Plant Betterment Engineer, Electric Bond & Share Co., New York, N. Y.
B. C. SMITH, President, Standard Motors Const. Co., Jersey City, N. J.
G. N. SOMERVILLE, Atlas-Imperial Diesel Engine Co., Oakland, Calif.

viscosity, Saybolt Universal, and a Conradson carbon content of 3 per cent. The load dropped off at the specified revolutions per minute, and the exhaust was slightly cloudy at all loads and the fuel consumption between 124 and 144 per cent normal. When the engine was shut down and left overnight it failed to start, and when the injection valves were inspected the tips were found to be covered with a tarry deposit. After cleaning the valves, considerable trouble was encountered in starting. Even then it took 20 min. to bring the engine to full-load capacity. In the engineer's opinion, the heavy deposit left in the cylinders renders the oil unsatisfactory for this engine.

### CONRADSON CARBON CONTENT

Another oil was tested, meeting the maximum A.S.M.E. viscosity specification on this grade of 100 sec., Saybolt Universal at 100 deg. F. The Conradson carbon of this product was 3.5 per cent. Fuel consumption was high and the power rating low. The exhaust-intake valves were coated with a gummy substance and had to be cleaned before the engine could be started. After considerable difficulty the engine was started. It required 30 minutes of idling before any load could be applied. During operation it was necessary constantly to apply penetrating oil to the valve stems to keep the valves free. After running 15 min. it was necessary to stop and clean the injection valve. The revolutions per minute constantly decreased during operation. Commenting on this oil, the engineer advises that during this test the exhaust was clearer than any of the oils tested, but the power was much lower, and considerable trouble was encountered and heavy deposits of pitch were left in the cylinder.

In analyzing these results it is apparent that Conradson carbon in excess of 1 per cent is unsatisfactory for the operation of motors of this size and speed. The committee has requested that this manufacturer blend sufficient quantities of the first-mentioned oil having a Conradson carbon content of 0.48 per cent with the second grade having a Conradson of 1.6 per cent, in such quantities that the carbon content will be slightly below 1 per cent; then test this oil under similar conditions and advise of the result. It is believed that these data should be of considerable interest, even though the viscosity will be considerably below the maximum set by this committee.

One other concern interested in motors of this type advises that, in field operation with motors widely distributed throughout North and South America, the best results are obtained with oils running between 40 and 60 sec., Saybolt Universal at 100 deg. F., and trouble has been experienced when using oils in excess of 70 sec. Consequently, it feels that 100 sec. Saybolt Universal would not be satisfactory for its engines. With reference to Conradson carbon, this concern states that it has operated engines successfully on quantities as high as 2½ per cent, but this is with California Diesel fuel, which is of entirely different characteristics from the average fuels east of the Rocky Mountains. Consequently, it is thought safe to say that the 1 per cent is considered satisfactory for them. The other figures specified are felt to be in line with its experience.

In light of these data it does not appear as though this specification would have to be modified to any great extent, although it is self-evident that the viscosity specification will have to be lowered in order that it might conform more closely with actual requirements.

### CONCLUSION

The committee has now arrived at the point where it becomes necessary to make a decision on the future policy in this work. One move will take it into studies to discover the cheapest oil which can be utilized in present Diesel engines. Apparently, if this is the goal, it will have to modify these specifications, perhaps in both classes of engines. The other turning will mean a search for the best compromise between boiler oil and the present cheapest oil which can be used in the present design of engines, but this compromise on oil will necessitate a redesign of Diesel machinery in many instances and the application of preheat apparatus. The committee feels that a decision between these policies is a matter which is the concern of the conference in general and the Diesel manufacturer in particular. Some decision should be made upon this subject, inasmuch as the work of this committee will come to a standstill shortly unless the future program is further defined.

## Safe Minimum Turbine Speed

TO FACILITATE quick starting of large turbines that have partly cooled, motor-driven turning gears are provided so that the rotors may be maintained in slow motion during idle periods, thus preventing distortion of the rotors and turbine stators due to unequal cooling or heating.

To determine the lowest speed at which an oil film can be maintained in the bearings, experiments have been made permitting a turbine to come to rest under its own momentum.

The breakdown point of the film was indicated by a sudden change in the rate of retardation. Extreme accuracy of instantaneous speed measurements was necessary, and was obtained by means of a 50 segment commutator fitted to the rotor to give 100 impulses per revolution to an oscillograph element. Another element in the oscillograph recorded a 60-cycle wave. The speed of the photographic film was approximately one inch per second.

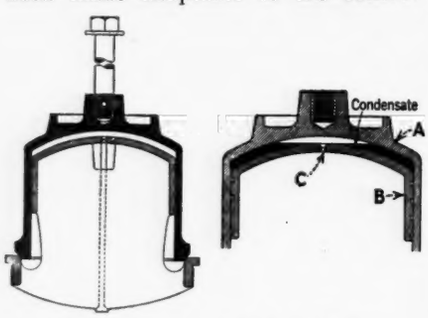
Curves showing the rate of retardation in revolution per minute per second, plotted against the speed of the turbine, indicated that the breakdown of the oil film takes place at about 18 r.p.m.—Institution of Mechanical Engineers "Journal Bearing Practice."

# WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

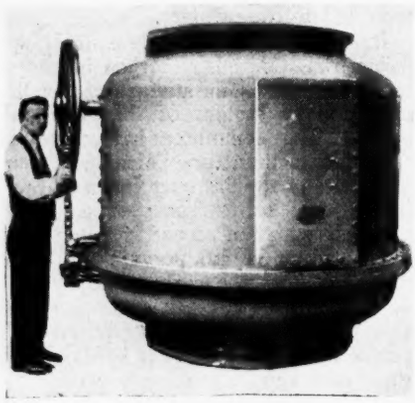
## Improved Multi-Port Valve for 125-Lb. Pressure

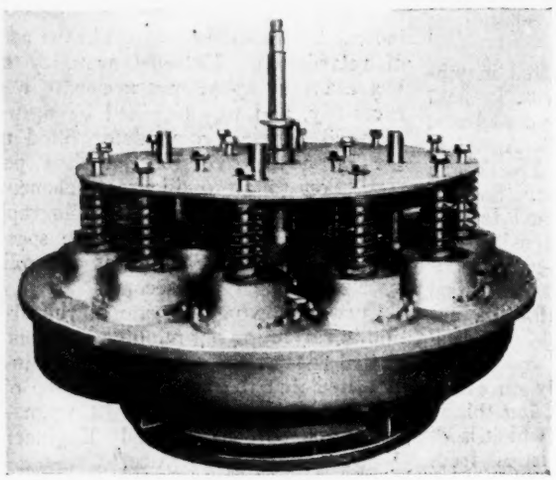
THE multi-port-type back-pressure valve put out by the Cochrane Corporation, Philadelphia, Pa., has been made adaptable to the control of steam from turbines or reducing valves on pressures up to 125 lb. by certain innovations in design. In the former construction the unbalanced valve disk was subjected to the full back pressure and a dashpot was used to prevent sudden action.




**Section of combined cushion chamber and valve**

In the new construction the pressure acts only on the annular area between the valve seat and the inside of the valve cylinder. Lifting of the valve is effected by pressure which builds up in the space between the head of valve cylinder *A* and plunger *B*, which is attached to, and forms a part of, the valve seat, as shown in the cross-sectional views. This pressure builds up or escapes slowly, through a small hole *C* in the top of the plunger. Thus there is little tendency for the valve to chatter. Owing to the fact that only a small amount of condensate can accumulate in the cushion chamber (see right-hand sectional view) the valve does not depend upon the presence of water, as in the former design. This feature makes the valve suitable for use with air, gas, or superheated steam.





**Exterior view of valve and deck assembly of sixteen valves**

For high pressures the valve is supplied with nichrome iron or cast-steel body; Everbrite valve disks, seats and cushion chambers; nitrided spindle; and alloy-steel springs. To facilitate adjustment of the valve while in service under high back pressure the spindle is fitted with a roller thrust bearing and the hand-wheel with a reduction gear.

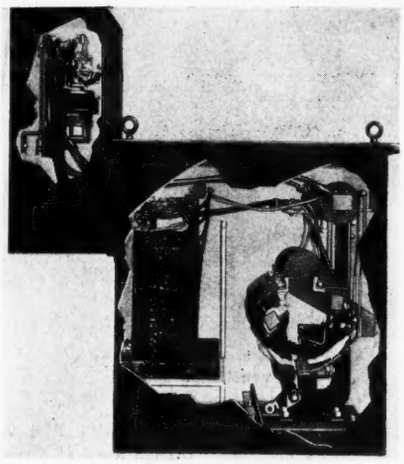
In the large-sized valves the casing is made of steel plate, with the top and bottom members built up from bumped heads with the nozzles and flanges welded on.

## Full-Voltage Magnetic Starter

ABSENCE of bell cranks, toggle mechanisms, and lever systems between the magnet armature and movable contact arm is a feature of a new 2,300-volt, full-voltage magnetic starter brought out by the Electric Controller & Manufacturing Company of Cleveland, Ohio. Complete with overload relays and a self-contained potential transformer (to secure 220 volts for the control circuit), it is intended for across-the-line starting of squirrel-cage and synchronous motors and may also be used to control the primary circuit of slip-ring motors. The starter is built for reversing, non-reversing, and plugging applications.

The magnet armature, carrying the movable contact arm, is direct-acting and is supported by only one large bearing pin. Contacts used on the new starter are also different from previous 2,300-volt designs. They open and close the circuit with a wiping and rolling action, and are duplicate and easily renewable.

A longer tank, containing two type ZHS magnetic contactors, mounted back-to-back and mechanically interlocked, is supplied for reversing, non-reversing, and plugging applications. This unit construction is said to provide a flame-, corrosion-, and dust-proof installation, making the starters

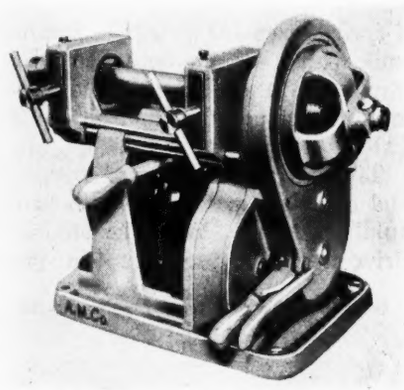


**Starter for squirrel-cage and synchronous motors**

suitable for installation alongside the motors they control. The starters are available in two sizes, with maximum ratings of 600 and 1,200, respectively. They may be controlled from a master switch that can be arranged to provide low-voltage release or low-voltage protection; also by float switches and similar devices.

## Pipe-Threading Machine With Revolving Die

ABILITY to thread long strands of assembled pipe or sections of bent pipe is a feature of a threading machine recently brought out by the Axelson Manufacturing Company, Ltd., Los Angeles, Calif. In this machine the pipe remains stationary and the die is revolved. The pipe is gripped by two-jaw chucks, and the threading is done by a standard



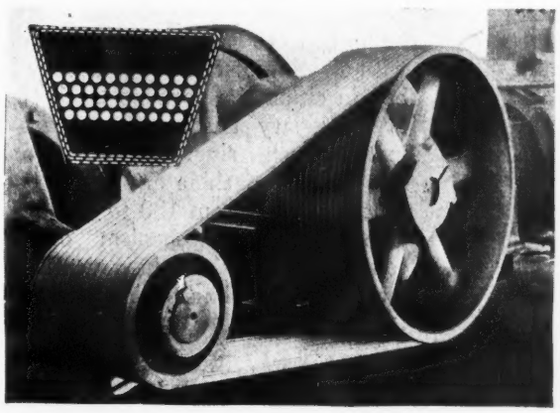
**Threading machine for pipe from ¼ to 2 inches**

square die. Power is supplied by a ½ hp. compound-wound motor mounted beneath the pipe holder brackets. The machine is designed to handle work from ½ to 2 in., and attachments are available for the cutter head to permit of cutting off, reaming, and bolt making.

## New Multi-V-Belt Drive

A "MULTI - V - DRIVE" developed in conjunction with the Goodyear Tire & Rubber Company, has been introduced by the Worthington Pump & Machinery Corporation, Harrison, N. J. This drive consists of a number of endless molded V-belts running in V-grooved sheaves. It combines a rubberized cord V-belt, impervious to dust and moisture, with an improved V-grooved sheave. The load-carrying members are high-grade cotton cords arranged in parallel lines and concentrated about the neutral axis.

Among the claims made for this



**Multi-V-belt drive consisting of endless molded V-belts that run in V-grooved sheaves**

belt are, high power capacity, long flexing life, low stretch, accurate cross-section, and high-quality rubber. Each sheave is grooved, machined, and finished, so that the grooves present a smooth surface on which the belts run. Quiet operation, small floor space, and higher speed ratios are other features.

## Non-Automatic, Stationary Acetylene Generators

TWO IMPROVED TYPES of non-automatic stationary acetylene generators for supplying large volumes of acetylene have been made available by the Oxweld Acetylene Company, 30 East 42d St., New York City. These generators are each made in two sizes having 500 lb. and 1,000 lb. carbide capacity.

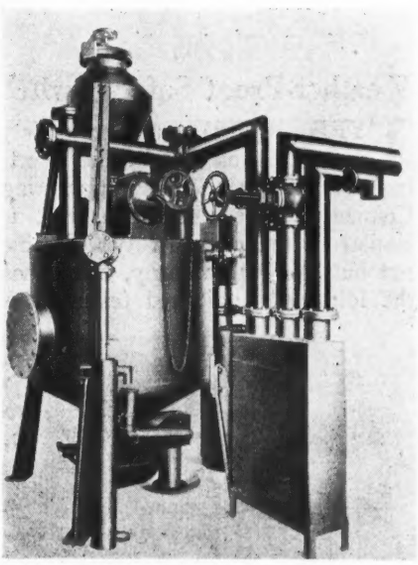
Type NA3 generator, shown in the illustration, is for plants using low-pressure welding and cutting apparatus, and it delivers to a storage holder which is weighted to supply acetylene to the piping system at a pressure of 20 in. water column.

Carbide is conveyed from the hopper to the generating chamber by a rotary feed screw driven by a slow-speed reciprocating water motor. The screw, being cast nickel, is resistant to wear and will not cause sparks.

From the generator the gas enters the wash box, where it passes through a water seal, which acts as a scrubber to remove any particles of residue. This device supplants the felt or hair filter usually employed.

The gas holder, of suitable size, may be placed either inside or outside the generator house, as best meets the needs of the particular installation. Except for an automatic water holder shut-off, which stops the carbide feed mechanism, all operations having to do with the starting and stopping of carbide feed must be performed by an attendant. For this reason, the generator is classed as non-automatic, that is, the carbide feed is not automatically governed by, or interlocked with, the immediate acetylene requirements.

Type NA4 generator is similar to

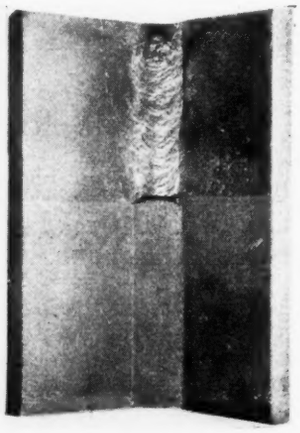


**Type NA3 acetylene generator**

type NA3, with the addition of an automatic booster system to deliver acetylene to the shop piping system at pressures not to exceed the permissible limit of 15 pounds.

## Putty to Improve Appearance of Welded Joints

WITH A VIEW to improving the appearance of welded joints, particularly on machinery with welded frames, bedplates, and other parts, a material known as Weldite fillet putty has been introduced by the Fusion Welding Corporation, 10257 Torrence Ave., Chicago, Ill.

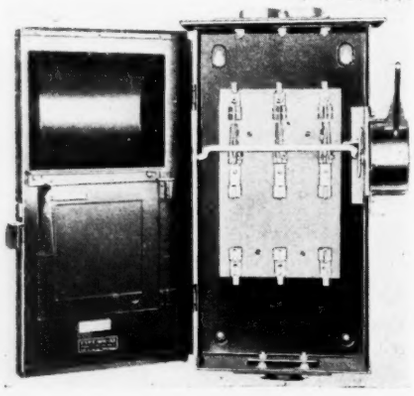


**Joint before and after applying putty**

It is claimed by the manufacturer that the putty is readily applied to weld beads in any type of joints or position, and will not loosen from shock or vibration. It is furnished in a powder form to be mixed as desired from paste to a consistency thin enough to be applied with a brush. The illustration shows a typical joint before and after applying a coat of the putty.

## Weather-Proof Safety Switch

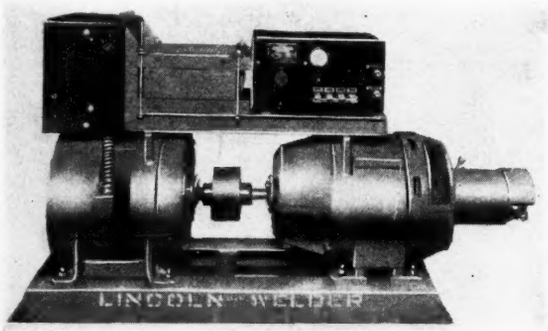
TYPE WK-55 outdoor safety switch, announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is similar to the standard WK-55 line put out by that company, but it has the following additional features: A drip cover of special cadmium-plated steel which permits water to drip clear of the switch; cast-iron cadmium-plated fittings, which, together with gaskets, are bolted to the drip cover and box, insuring water-tight joints for conduit. The base, of ebony asbestos, has a high dielectric strength and is non-moisture absorbing and durable.



**Safety switch with door open**

## High-Capacity Electric Welder

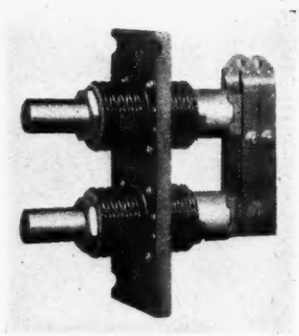
TO MEET the demand for higher welding current for large-sized metallic and carbon electrodes, the Lincoln Electric Company, Cleveland, Ohio, has brought out a new welder with a rating of 600 amp. It may be had in either the portable truck type or stationary truck type. It is a motor-driven, single-operator, variable-voltage machine and has a current range of from 180 to 750 amp. The working mechanism of all controls is contained in a ventilated inclosed steel cabinet, with hand regulators and switches mounted on a panel that forms a side of the cabinet. The control panel contains rheostat, diverter switch, safety starter switch, volt ammeter, and wing nut terminals for cables. This unified control increases the simplicity of the operation of the welder. The face of the volt-ammeter is mounted flush with the control panel, assuring protection against damage.




**Welder has current range of from 180 to 750 amperes**

## Ventilated Stud Disconnect Switches

THE Delta-Star Electric Company, Chicago, Ill., has developed the new form of high-capacity tongue-type back-connected disconnecting switch illustrated. An important feature is the use of hollow studs with openings at both ends, giving free circulation of air throughout the entire length. There are no brazed or soldered joints, and the cast base is made of high-strength bronze.



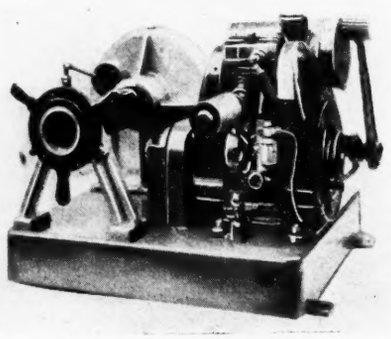
**Twin-blade switch with ventilated studs**

## Pipe Machine With Gasoline Engine Drive

NUMBER 412 Power Boy, put out by the Oster Manufacturing Company and the Williams Tool Corporation, Cleveland, Ohio, is now available with a gasoline engine drive. The motor is a 1-hp., single-cylinder, 4-cycle, air-cooled Briggs & Stratton unit with a $2\frac{1}{4}$ in. bore and $2\frac{1}{4}$-in. stroke. An easily operated hand starter is standard equipment and an Eclipse clutch is provided.

The new unit is designed to thread and cut pipe up to 2 in. without an auxiliary drive. With the auxiliary drive it can be used for 4-in. pipe.

**Gasoline engine-driven pipe-threading machine**



# NEWS of the FIELD

## *Spot News*

GOVERNOR ROOSEVELT *named on Aug. 13 the special commission authorized by the last State Legislature to formulate a plan for state development of hydro-electric resources on the St. Lawrence River, as follows: Chairman, Robert M. Haig, professor at the school of business, Columbia University; Frederick M. Davenport, member of Congress, professor of law and politics at Hamilton College; Julius Henry Cohen, counsel to the Port Authority of New York and New Jersey; Thomas H. Conway, former Lieutenant-Governor of New York; and Samuel L. Fuller, banker and member of the firm of Kissel Kinnicut & Company.*

PRELIMINARY CONSTRUCTION *on the second section of State Line Generating Company's station near Hammond, Ind., was started last week. As announced in Power of Feb. 4, two units, aggregating 257,000 kw. capacity, will be installed in the second section, bringing the total station capacity to 465,000 kw. Both units will operate at 1,200 lb. pressure; one will be completed in 1932 and the other in 1933.*

APPLICATIONS *for the development of approximately 175,365 hp. on the Klamath River between the Grant power site and the California line have just been filed with the Oregon State Engineer by the California-Oregon Power Company. The cost of the proposed project is estimated at $20,600,000.*

WHAT IS BELIEVED *to be the largest contract for boiler equipment ever placed in this country has just been awarded the Combustion Engineering Corporation by the Brooklyn Edison Company for eight 24,450-sq.ft. boilers and accessories to be installed in the Hudson Avenue generating station. The contract includes superheaters, water-cooled furnaces, economizers, settings and steel work. Serving two 160,000-kw. turbine-generators, these boilers will each have a maximum steam output of 530,000 lb. per hour.*

## Duke of York Inaugurates Lochaber Plant, Britain's Greatest Hydro Project

**Fifteen mile tunnel cut through rock is notable engineering feature of this 120,000 hp. development.**

GREAT BRITAIN'S greatest hydro-electric project, that at Lochaber, has just been inaugurated by the Duke of York. In magnitude, in boldness of design, and in the engineering difficulties attendant on its execution, the Lochaber project will bear comparison with many projects of a similar nature carried out in countries enjoying much larger water-power resources than Britain.

When the scheme is completed in all its stages water will be collected from an area of over 300 square miles and will be conveyed through a long rock tunnel to Fort William, where it will be used in a single power house having a capacity of 120,000 hp. The current generated will be chiefly utilized at Fort William for the manufacture of aluminum in a factory that will ultimately employ thousands of men.

The works thus far carried out are complete in themselves, and already power has been generated and metal manufactured. The central feature of the works comprising the first stage is the pressure tunnel, fifteen miles long, which follows an irregular but roughly semi-circular route round the north of the Ben Nevis massif and conveys water from Loch Treig to the power house at Fort William, also intercepting various mountain streams by which it is crossed. Loch Treig is a deep, narrow lake, about five miles long and over one-half mile across at its widest point, which serves as a natural reservoir to equalize the supply of water in wet and dry periods. At present it constitutes the eastern limit of the system, but in time it will be connected by a four-mile tunnel with another long, narrow lake, Loch Laggan, and this, in turn, will receive water diverted from the upper reaches of the Spey, which is another watershed, that discharges into the Moray Firth.

The Treig Tunnel is a notable feat of engineering. Its length of fifteen miles makes it the longest tunnel in Britain. It follows the contour of the mountain, and the surveys required to lay out its course were a complicated task. Boring was begun in the summer of 1926, and by February, 1929, there was a continuous passage from end to end except for a rock barrier left at the Loch Treig inlet. The work of driving it was carried out simultaneously from a number of faces provided by seven horizontal adits and four vertical shafts. The length of these adits ranged from 400 to 1,440 ft., the total being 6,360 ft., and the depths of the shafts from 145 to 356 ft., with a total, including one at the Fort William end, of 1,030 feet.

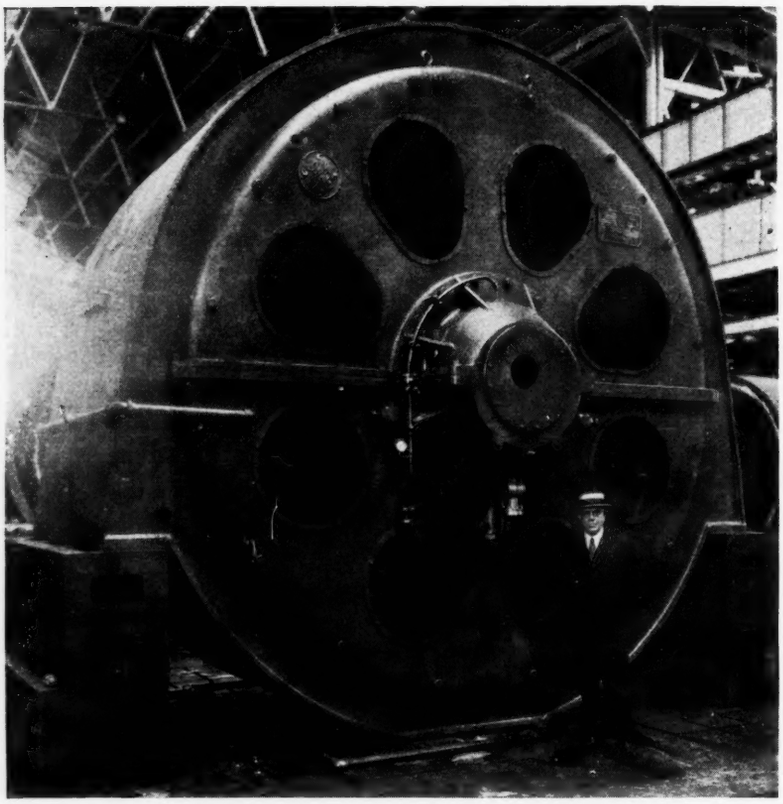
Besides serving for constructional purposes these adits and shafts are employed as intakes through which, by means of dams and conduits, large quantities of water are directed into the tunnel from streams flowing down the north side of the Ben Nevis range. About 1,500,000 tons of rock had to be excavated by drilling and blasting, and 45,000 tons of cement were used in forming the concrete lining.

AT THE OTHER (Fort William) extremity, the tunnel ends at a surge shaft, 30 ft. in diameter and 240 ft. deep. Two steel pipe lines lead down from the valve house to the power house, a distance of some 3,200 ft. Beginning at 70½ in. in the upper sections, their diameter declines to 65 in. in the lowest section, where the thickness of their walls is increased to 1⅛ in. The 30-ft. lengths of which they are composed were electrically welded together on location—a method never before employed in Britain.

In its present form the power house is a structure 270 ft. long and 65 ft. wide, and is fully occupied with generating plant, the capacity of which is less than half what will be required when water is gathered from the full area included in the scheme. The design, however, provides for enlargement. The site on which the station stands is excavated to a depth of some 40 ft. below ground level, and the turbine pits are still lower. The result is that with the level of Loch Treig at 783 ft. the gross head available is 764 ft., but will be increased to 800 ft. when the level of that lake is raised by a dam at its lower end, which is the ultimate intention.

The generating plant so far installed comprises five main 10,000-hp. direct-current units driven by turbines of the Pelton wheel type, and two subsidiary turbine-alternators of 1,250-kw. each, with Boving waterwheel turbines.

## PROPULSION MOTOR FOR NEW LINER



**One of two main propulsion motors for the first of the new turbine-electric passenger liners of the Dollar Line being built by the Newport News Shipbuilding & Dry Dock Company. The view shows the motor in the General Electric shops, where it is made. It is rated 13,250 shaft horsepower and will turn the propellers at a speed of 125 r.p.m.**

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## Ford Orders Large Pumps for River Rouge Plant

An order from the Ford Motor Company for four vertical propeller-type pumps with synchronous driving motors and control to be installed at the River Rouge plant near Detroit was recently placed with the Westinghouse Electric & Manufacturing Company. The four pumps are to be used as boosters for furnishing the whole water supply to the River Rouge plant. The capacity of each pump is 157,500 gal. per minute against a 14.5-ft. total head.

The pumps will be installed in a circular house beneath the surface of the ground, with the center line of suction tunnel at an elevation of 44 ft. 6 in., the center line of discharge tunnels at an elevation of 72 ft., and the motor floor at approximately the ground level, at an elevation of 106 ft. 6 in. Extension shafts with proper steady bearings will be provided between pumps and motors.

The synchronous motors are of the vertical type, completely fabricated by arc welding. Each pump will ultimately have three operating speeds—277 r.p.m., 200 r.p.m., and 138 r.p.m. The 277-r.p.m. and 138-r.p.m. speeds will both be obtained from a single two-speed motor. This motor and its control are arranged so that both the stator and rotor may be connected for either 26- or 52-pole operation, these numbers of poles corresponding, respectively, to the two speeds of 277 and 138 r.p.m. At those speeds the motor is rated at 700 hp. and 350 hp.

Only one motor is being installed at the present time. However, a "dummy" frame of the same dimensions as the 200-r.p.m. motor is being provided so that it may be installed above the two-speed machine when required, by removing the frame and putting the motor in its place. The 200-r.p.m. motor will be rated at 350 horsepower.

Due to the requirements of continuity of service, with a possible operating voltage of 75 per cent of normal and the torque required by this type of pump, the synchronous motors are designed with unusually high starting and pull-in torque. Excitation is obtained from two 60-kw. motor-generator sets, each having sufficient capacity to excite all four motors. The control is vertical lift type reduced-voltage starting through reactors, and starting the motors and operating the pump valves is accomplished from a single switch.

## New Units Installed to Meet Demands of Transvaal

Presiding at the annual meeting of the Victoria Falls & Transvaal Power Company, Ltd., recently held in London, the Marquis of Winchester stated that the net profit of the undertaking for 1929 amounted to $1,901,650, the highest figure on record. In the course of his remarks the Marquis said that the demand for electric power is still increasing in South Africa, and notifications of further requirements have been received. He believes the upward movement will continue for some time, despite the fact that during the year three of the older mines practically ceased to take power. Supply is now furnished to 35 mines, which take 97 per cent of the total output of the company.

The fifth 20,000-kw. machine at Witbank will be on the line very shortly; the new 20,000-kw. unit for Brakpan and the 32,500-kw. unit for Vereeniging have both arrived on the site and are in course of erection. They will be at work during the fall. When these machines are in service there will be sufficient margin in electrical plant to allow time for further plant installation should increased demand render it necessary.

The demand for compressed air has called for an additional air plant, and the undertaking has in hand the establishment of a new electrically driven station at Canada Dam containing two 8,000-hp. air compressors. The ultimate installed capacity cannot be definitely forecast, but it is almost certain that further additions will have to be made.

## Fastest Electric Liner on Maiden Trip This Week

The Morro Castle, new electric liner for the Ward Line of the New York and Cuba Mail Steamship Company, will make her maiden voyage from New York to Havana on August 23. This boat and her sister ship, the Oriente, both built by the Newport News Shipbuilding and Dry Dock Company, will be the fastest turbine-electric passenger ships afloat. Designed for a speed of 20 knots, they will reduce the New York-Havana run from 72 to less than 60 hours, the fastest time ever maintained by a liner in this service.

In the power plant, steam will be generated in oil-fired, Babcock & Wilcox boilers, and will be fed to the turbines at 275 pounds gauge pressure and 200 deg. F. superheat. The turbine-generators will be two General Electric machines each running at a speed of 3,150 r.p.m. and rated 3,000 volts. The generators will be equipped with surface air coolers.

There will be two propulsion motors installed on each ship. These will be of the synchronous induction type, direct connected to the propeller shafts and having a normal rating of 6,250 hp. at 134 r.p.m. each.

## Plans for Chicago Power Conference Progressing

Twenty representatives of the foremost engineering societies in the power field met recently in Chicago to outline plans and arrangements for the Fifth Midwest Power Engineering Conference. Past meetings of the conference have been held in Chicago since 1925, and the next meeting promises to be of greater importance that any before.

The work of carrying on the four-day meeting scheduled for Feb. 10 to 13, 1931, inclusive, at Chicago will be in the hands of the following officers recently elected: President—H. W. Fuller, Byllesby Engineering & Management Corporation; Vice-presidents—C. C. Whittier, Chicago; W. M. White, Milwaukee, Wis.; Charles S. Gladden, Detroit, Mich.; Paul Doty, St. Paul, Minn.; John Hunter, St. Louis, Mo., and Prof. A. C. Willard, Urbana, Ill. G. E. Pfisterer is secretary, and K. A. Auty treasurer.

The conference will be sponsored by the local sections and regional divisions of the following: A.S.M.E., A.I.E.E., A.S.C.E., A.I.M.E., A.S.R.E., N.E.L.A., National Safety Council, and Western Society of Engineers

Several committees have already started work for the four-day meeting, and a canvass is being made to secure the latest ideas and most modern applications of power and its allied subjects. The rapid progress in this field, and in the field of physics, so closely allied, will allow a presentation of subjects of national interest. Leading authorities in the heating, refrigerating, mining, electrical, and mechanical fields will be asked for expressions of the progress of power application in these fields.

## Survey Potomac River for Power Development

A report of the potential resources of the Potomac River in respect to power development, navigation, and flood control will be submitted to the War Department during the last part of August by the engineer officer in charge of the Washington, D. C., district. This report is part of the general survey of the nation's water resources authorized during a previous session of Congress. Under the general survey the army engineers are directed to report on power possibilities, flood control, irrigation, reclamation, and navigation. In the case of the Potomac, however, only the part of the study concerning power development and navigation is of particular value.

While the details of the report are not available, it has been established that the Potomac is one of the most promising streams in the South Atlantic section for power development purposes. According to the army engineers, this is because the Potomac is more susceptible to control, since its upper reaches flow through relatively undeveloped sections where there are no drawbacks to the construction of ample storage basins. Thus while the river does not possess as much total power possibilities as some of the other streams in the Middle Atlantic section, its ease of control makes it adapted to an interconnected system.

## Garland Opens New Addition to City Diesel Plant

A $25,000 addition to the municipal light plant at Garland, Texas, began operation Aug. 8 while 10,000 people representing north Texas and southern Oklahoma celebrated the event. T. A. Sidley constructed the new 25 x 80-ft. brick building on a percentage basis at a cost of $3,875. Fairbanks-Morse Engine Company, Chief Engineer C. E. Newman, and City Electrician Henry Bailey installed the $3,520 switchboard and the 240-hp. Deisel engine costing $17,604. Total plant valuation, including one 150- and two 100-hp. engines, is $94,164.43.

No bonds have ever been issued for the power station. The plant has paid off indebtedness from receipts on charges of 15c. per kilowatt-hour, less 25 per cent discount for payment before the tenth of the month. The town is illuminated by 500 street lights without cost to taxpayers. Taxes have been reduced from $1.50 in 1923 to 90c. in 1930.

# News of Canada

### Edmonton and Calgary Power Company enter agreement to exchange steam and hydro power

IN CONNECTION with the operation of the recently completed Ghost hydro-electric plant in the Province of Alberta, an interesting interchange of power agreement has been entered into between the Calgary Power Company, owners of the plant, and the city of Edmonton. Heretofore, the city has drawn its entire supply of electricity from the municipal steam-electric generating station. Now the city will draw practically half of its supply from the Ghost plant. The 36,000-hp. hydro station is linked with the 22,000-hp. steam station over the highest-voltage transmission line in Western Canada, carrying the current at 132,000 volts. The transmission line is designed to carry 30,000 kw. and with the 16,000 kw. available from the Edmonton steam plant the city has a maximum power supply of 46,000 kilowatts.

Actually this amount is not guaranteed, at least for all seasons of the year, as the arrangement between the city of Edmonton and the power company is for an interchange of power whereby

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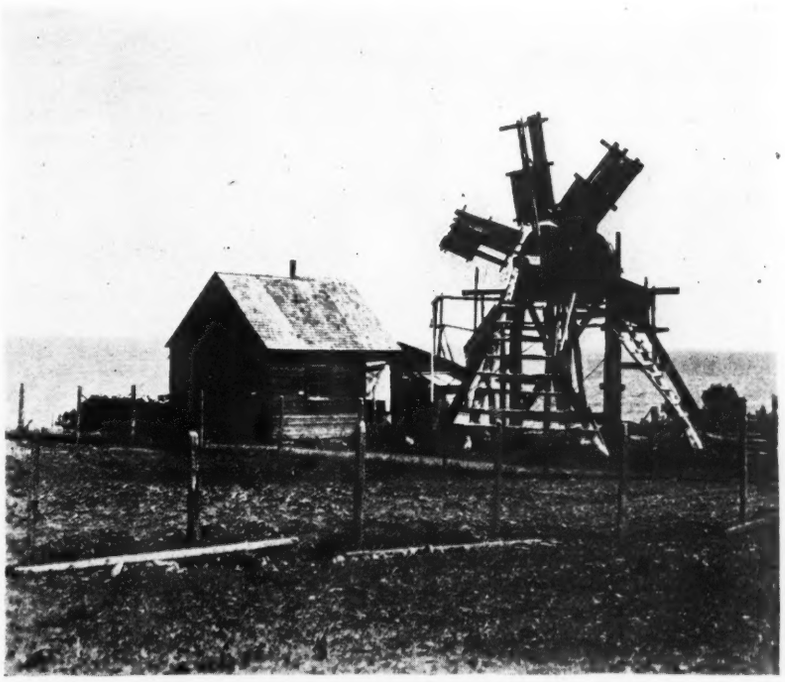
## POWER FOR THE SIMPLE LIFE



**Way up on the north shore of the Gaspe Peninsula, near Petite Madeleine, Quebec, where life is simple and the need for power is small, this is how they provide it. Many years old, these windmills are constructed entirely of wood, even the sails**

Edmonton secures the hydro power when water conditions are favorable on Bow River. In case of low water, the Calgary Power Company will have the privilage of purchasing steam-generated power from the municipal plant for use on its lines. Under the agreement, covering a five-year term, Edmonton secures electricity from the Calgary Power Company at the rate of 0.5c. per kilowatt-hour for the first 20,000,000 kw.-hr. delivered per year and in excess of that amount at 0.4c. When the Calgary Power Company finds it necessary to purchase steam-generated electricity from the city plant it will be paid for on the basis of cost plus 10 per cent. The interchange of power agreement does not effect the distribution of electricity within the boundaries of Edmonton, which will continue as a civic utility.

The arrangement to interchange power with Edmonton made possible the construction of the long high-power transmission line from Bow River, which would not have been feasible on the basis of supplying power to the small towns alone. The high-tension line to Edmonton involved a cost of slightly over $1,000,000, while the entire program in water-power development and transmission lines in the last two years is reported to have involved the expenditure of $9,000,000, a program which has carried electricity into many towns previously without a power supply.

## How's Business?

BUSINESS activity increased last week and our indicator moved upward for the first time since the beginning of July. It stands at 87.4% of normal as compared with 86.5% a week ago and 113.7% a year ago. The upturn occurred in spite of disposition of many business men to sit tight until effects of the drought can be more accurately appraised. These, as early exaggerations fade, will be discovered not to be calamitous.

There is reason to believe the worst is over—the recovery has begun; that it will be rapid as compared with recovery in 1921. Check payments increased last week; so did freight shipments of commodities. Productive activity decline was less steep. Chicago grain traders evidently agree that early drought damage reports were exaggerated; grain prices sagged. Other raw material prices continue to weaken. Approach of fall weather will start the seasonal upswing; renewed buying will strengthen prices.—*The Business Week*, Aug. 20.

## New Pump for Indianapolis

The Indianapolis Water Company is engaged in a program of improving its pumping facilities, the total cost of which will exceed $500,000. The central feature of the program is the installation of a new steam-turbine-driven centrifugal pumping unit to have a capacity of 40,000,000 gal. daily. The new unit will operate at the Riverside pumping station, and new suction and discharge piping is being installed in anticipation of its delivery.

## Civil Service Exams for Boulder Dam Work

The United States Civil Service Commission announces open competitive examinations for positions in connection with the Boulder Dam project and also in connection with design and specifications for the proposed All-American Canal of the United States Reclamation Service. The positions to be filled and the salaries are: principal civil engineer, $5,600 to $6,400; senior civil engineer, $4,600 to $5,200; senior electrical engineer, $4,600 to $5,200; senior mechanical engineer, $4,600 to $5,200; civil engineer, $3,800 to $4,400; mechanical engineer, $3,800 to $4,400.

Applications must be on file with the Civil Service Commission at Washington, D. C., not later than Sept. 10. Competitors will not be required to report for examination, but will be rated on their education, experience and fitness. Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service board of examiners at the post office or custom house in any city.

## Rate Reduction Ordered for Boston Edison

A rate cut estimated to reduce the operating revenues of the Edison Electric Illuminating Company of Boston, Mass., by approximately $1,300,000 a year on the present volume of business will become effective Sept. 1 by order of the Massachusetts Department of Public Utilities. The order follows the conclusion of a protracted investigation of the company's rates by the board and petitions by the city of Boston and other municipalities for lower prices.

The maximum rate under this order is 7½c. per kilowatt-hour on the company's general rate, residence rate and general small power rate. The present maximum is 8½ cents.

An interesting feature of the case was that the reproduction theory of rate basing was not involved.

# Personals

FREDERICK HENRY LOW has been appointed secretary and general manager of the King Refractories Company of Buffalo, N. Y. Mr. Low, son of F. R. Low, editor emeritus of *Power*, has been engaged for several years past in plant engineering development for the Ford Motor Company. He has also been active in the affairs of the American Society of Mechanical Engineers, serving as chairman of the Detroit Section.

C. E. HARRINGTON, assistant dean of the College of Arts and Sciences, University of Buffalo, was recently elected president of the Buffalo Section of the American Society of Mechanical Engineers. Other officers elected are: vice-president, HAROLD L. SMITH, consulting engineer; secretary, H. D. MUNSON, mechanical superintendent of the Mathieson Alkali Works; and treasurer, WILLIAM M. DOLLAR, consulting engineer.

E. M. LINDSAY, formerly superintendent of distribution of the Florida Power Corporation, is now supervising engineer on the staff of the Standard Management & Operating Corporation of San Francisco, Calif. Mr. Lindsay will have charge of all construction work on natural gas plants and distributing systems, as well as supervising any electrical construction that may be undertaken by the corporation.

E. S. BUNDY, of the Buffalo, Niagara & Eastern Power Corporation, was recently elected chairman of the Niagara Frontier Section of the American Institute of Electrical Engineers. Other officers elected are: vice-chairman, RAYMOND T. HENRY, Buffalo, Niagara & Eastern Power Corporation; secretary and treasurer, GEORGE W. EIGHMY, General Electric Company, Buffalo, N. Y.

W. H. KENDRICK has been made general superintendent in charge of operations of all departments of the Broad River Power Company, with headquarters in Columbia, S. C. Mr. Kendrick, formerly engineer in charge of operations for the company, has had a wide experience with many utilities in the East.

DR. HAROLD E. SIMPSON has been appointed a member of the Battelle Memorial Institute staff as a specialist in ceramics to assist CLYDE E. WILLIAMS, assistant director, and R. A. SHERMAN, chief fuel engineer at the Institute, on an investigation dealing with the slagging action of coal ash on boiler furnace refractories.

MAJOR AARON E. CARPENTER, first vice-president of E. F. Houghton & Company, Philadelphia, Pa., has just returned from an extended business survey in France, Germany, Poland, Russia and England.

# Business Notes

CHAIN BELT COMPANY, Milwaukee, Wis., announces that the following new distributors will handle its various Rex products: Equipment Corporation of Arizona, Phoenix; F. C. Crane Company, Dallas, Texas; Joe C. Tucker, Morganfield, Ky.; Track-Type Tractor & Equipment Company, Amarillo, Texas; Concrete Products Company, Oakland, Calif.; and E. C. Atkins & Company, Memphis, Tenn. The Atlanta office of the company has recently been moved to 407 and 408 Bona Allen Building.

CHARLES C. PHELPS, 11 Park Place, New York City, has been appointed sales agent for metropolitan New York and northern New Jersey by the Leavitt Machine Company, Orange, Mass.

MCCLAVE-BROOKS COMPANY, Scranton, Pa., announces the appointment of S. C. Orell as manager of the Chicago district territory. Mr. Orell was formerly district sales manager for the Murray Iron Works of Burlington, Ia.

VITREFRAX CORPORATION, Los Angeles, Calif., has appointed the Nedmac Company, 33 South Front St., Philadelphia, Pa., as distributors of its products.

THE UNITED STATES COURT at Columbus, Ohio, has decided that the laminated, die-cut, raw-edged V-belt of the Dayton Rubber Manufacturing Company, of Dayton, Ohio, is a new structure and the basic patent covering it is valid. This decision was handed down by the court in suit brought by the Dayton concern against a distributor and manufacturer of infringing belts.

CUTLER-HAMMER, INC., Milwaukee, Wis., has acquired the Reynolite Division of the Reynolds Spring Company of Jackson, Mich.

PRAT-DANIEL CORPORATION, New York City, announces the appointment of C. B. McBride as a member of the sales department at its main office in New York City.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has promoted James S. Fenton to the position of sales engineer of the New York office.

LINK-BELT COMPANY, Pacific Division, has just moved into its new manufacturing plant and office on Paul Avenue near Bayshore Highway, San Francisco, Calif., from its old plant in a different section of the city. This added unit to Link-Belt's sixteen plants and warehouses, located throughout North America, consists of a two-story office building of Spanish design; a warehouse 80 ft. by 120 ft., three stories high; and a manufacturing building, containing the machine shop, steel shop, plant office and auxiliary departments.

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# COMING CONVENTIONS

**American Society of Mechanical Engineers.** Fall meeting at French Lick Springs, Ind., Oct. 13-17. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

**American Institute of Electrical Engineers.** Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

**American Welding Society.** Fall meeting at the Congress Hotel, Chicago, Ill., Sept. 22-26. Secretary, M. M. Kelly, 33 West 39th St., New York City.

**Midwest Power Engineering Conference.** Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

**National Association of Power Engineers.** Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

**National Association of Practical Refrigerating Engineers.** Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

**National Power Show.** Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

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# Trade Catalogs

FURNACE ARCHES—An interesting bulletin, Catalog No. 17 of the Bigelow-Liptak Corporation, 5057 Woodward Ave., Detroit Mich., describes the features of Liptak double-suspension arches for furnaces. Attractively illustrated in color, the catalog gives full details of construction and application of these arches.

INSULATION—Bulletin No. 10, just issued by the Rockbestos Products Corporation, New Haven, Conn., gives construction specifications and applications of Rockbestos insulated wires and cables for use in industrial plants and central stations wherever wiring is exposed to heat, moisture, fumes, acids, vapors, oil or grease.

CONDENSERS—A new edition of Bulletin 5-AA covering SK barometric multi-jet condensers has recently been published by Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa. New installation illustrations and performance charts are included in the new edition. The company has also issued a revised edition of Bulletin 8-R on reducing valves and regulators.

SWITCHES—Bulletin No. 33 of the Pacific Electric Manufacturing Corporation, 5815 Third St., San Francisco, Calif., describes and illustrates high-tension switches and circuit breakers. Constructural features, wiring diagrams, and installation views are included.

MOTORS—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo., announces the publication of a new 16-page bulletin, No. 171, on Fynn-Weichsel motors. This bulletin contains a discussion, complete with curves and illustrations, of the problem of poor power factor and the application of this motor to its solution. Constructional details and applications of the motor occupy a part of the booklet; another section is devoted entirely to control equipment.

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# Fuel Prices

## COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

| **Bituminous** (Net Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Navy Standard | New York | $2.25 @ $2.50 |
| Kanawha | Cincinnati | 1.10 @ 1.35 |
| Smokeless | Cincinnati | 1.75 @ 2.00 |
| Smokeless | Chicago | 1.75 @ 2.00 |
| West Kentucky | Louisville | .85 @ 1.25 |
| Steam | Pittsburgh | 1.30 @ 1.60 |
| Gas Slack | Pittsburgh | .90 @ 1.00 |
| Big Seam | Birmingham | 1.60 @ 1.75 |

| **Anthracite** (Gross Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Buckwheat | New York | $3.00 |
| Barley | New York | 1.15 @ 1.50 |

## FUEL OIL

**New York**—Aug. 14, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

**St. Louis**—Aug. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg. $1.600 per bbl.; 32@36 deg., gas oil, 3.901c. per gal.; 38@40 deg., distillate, 4.651c. per gal.

**Pittsburgh**—Aug. 6, f.o.b. local refinery, 34@36 deg., fuel oil, 3.12½c. per gal.; 36@40 deg., 3.25c.

**Philadelphia**—Aug. 3, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

**Cincinnati** — Aug. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

**Chicago**—Aug. 4, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $0.90 per bbl.

**Boston**—Aug. 11, tank-car lots, f.o.b., 12@14 deg., Baumé, .033c. per gal.; 28@32 deg., 5c. per gal.

**Dallas**—Aug. 9, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

# New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Calif., Los Angeles**—State of California, received lowest bid for the construction of a 12 story office building including steam heating system, elevators, etc. at First and Spring Sts. from Weymouth Crowell Co., 2104 East 15th St., Los Angeles. Estimated cost $1,150,000.

**Colo., Lake City**—R. D. Webb, plans the construction of a hydro-electric plant and dam on Lake fork of Gunnison River. Estimated cost $500,000.

**Conn., New London**—U. S. Coast Guard Academy, had plans prepared for the construction of a group of buildings including power plant, etc. on Mohegan Ave. Estimated cost $1,750,000. Private plans.

**Conn., Newtown** — Fairfield State Hospital Commission, State Capitol, Hartford, awarded contract for the construction of a group of buildings including garage, fire station, carpenter and paint shops, laundry, power house, coal bunker, etc. at Mile Hill, to C. Abadessa & Bros., Inc., 159 Winthrop Ave., New Haven. Estimated cost $1,750,000.

**Ga., Eastman**—F. R. Bennett, plans the construction of a cold storage plant. Estimated cost $35,000.

**Ind., Indianapolis**—City Hospital, 960 Locke St., awarded contract for the construction of a new power plant including motor placing, changing current, etc., to Sanborn Electric Co., 309 North Illinois St. Estimated cost $65,000.

**Mass., Lynn**—City, will soon award contract for the construction of a police station, and boiler house. Estimated cost $200,000. Private plans.

**Mass., Malden**—Kendall, Taylor & Co., 209 Columbus Ave., Boston, Archts., will receive bids until Aug. 25, for the construction of a hospital including steam heating and ventilation systems, etc. on Hospital Rd. for Malden Hospital, E. P. Bliss, Chn. Estimated cost $1,200,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer.

**Mass., Springfield**—City will receive bids until Aug. 28, for the construction of a 3, 4 and 5 story hospital including steam heating and ventilation systems on State St. Estimated cost $500,000 to $600,000. Kirkham & Parlett, 25 Harrison Ave., are architects.

**Mich., Detroit**—Bd. of Education, C. A. Gadd, Bus. Mgr., 1354 Broadway Ave., will receive bids until Aug. 20 for the construction of a 2 story school, including boiler house and heating plant on Braden St. Estimated cost $160,000. Donaldson & Meier, 1188 First National Bank, are architects.

**Mich., Detroit**—Public Light Commission, J. S. Foley, Secy., 138 East Atwater St., will soon award contract for the construction of a 2 story sub-station for Dept. of Street Railways. Estimated cost $150,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., are engineers.

**Miss., West Point**—City awarded contract for 700 to 900 hp. Diesel engines direct connected to electric a.c. generator, also exciter switchboard and accessories, to Nordberg Mfg. Co., Chicago and Oklahoma Sts., Milwaukee, Wis. $63,352.

**Mo., St. Louis** — Illinois Terminal Railroad, Shell Bldg., plans the construction of a 20 story office, warehouse and terminal at 12th, High and Morgan Sts. and Lucas Ave. Estimated cost $5,000,000. Mauran, Russell & Crowell, Chemical Bldg., architects. Contract let for excavation, to G. Locke Tarlton Co., Ambassador Bldg.

**N. J., Roebling**—Bd. of Education, Florence Township, plans the installation of a new heating plant in school here. $10,000.

**N. J., Skillman**—Dept. of Institutions & Agencies, State Office Bldg., Trenton, will receive new bids until Aug. 22 for a 2 story, 70 x 90 ft. power house at State Village for Epileptics. Estimated cost $100,000. Former bids rejected.

**O., Cleveland**—Dept. of Welfare, A. T. Connan, Dir., Ninth and Oak Sts., Columbus, awarded contract for the construction of a cold storage plant, kitchen and bakery at Cleveland State Hospital here to G. H. Moehlman, Norwalk. $70,400.

**O., Columbus**—Bd. of County Comrs., Franklin County, will receive bids until Aug. 22 for alterations and additions to power house at Franklin County Home.

**Okla., Muskogee**—City is having preliminary plans prepared for the construction of a municipal electric light plant for street lighting uses. Estimated cost $75,000. E. Brock, Muskogee, is engineer.

**Okla., Woodward**—City is having preliminary plans prepared for the construction of a municipal electric light plant. Estimated cost $125,000. H. M. Renner, is engineer.

**Oregon**—California-Oregon Power Co., 454 California St., San Francisco, has made application for six power sites on Klameth River, here. Estimated power and cost as follows: first site, 70,000 hp. $7,000,000; second, 34,091 hp., 200 ft. fall, $4,000,000; third 36,447 hp., 214 ft. fall, $4,500,000; fourth 65,455 hp., 384 ft. fall, $5,500,000; fifth 17,045 hp., 100 ft. fall, $2,600,000 and sixth, 22,295 hp., 166 ft. fall $4,000,000. Total estimated cost $27,600,000. R. Luper, Salem, Ore., is engineer.

**Ore., Portland**—Hill Military Academy, is having plans prepared for the construction of a group of school buildings including central heating plant. Estimated cost $500,000. Tourtellottet & Hummel, Postal Bldg., are architects.

**Pa., Pittsburgh**—R. Bowler, 350 South Aiken Ave., awarded contract for the construction of an 85 x 100 ft. garage including boiler room, to C. Valenti, 6423 Bennett St.

**Pa., Tarentum**—City plans addition to municipal light plant, also changes in present generator and installation of a new 1,000 kw. generator. Estimated cost $150,000.

**Pa., Warren**—Commonwealth of Pennsylvania, Warren State Hospital, will receive bids until Aug. 27, for alterations and additions to cold storage plant. J. E. Woodwell, 501 5th Ave., New York, N. Y., is consulting engineer.

**R. I., Melville**—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a power plant here, to Coleman Construction Co., 86 Weybosset St., Providence. $42,317.

**Tex., Port Arthur**—City, will receive bids until Aug. 26 for the construction of a drainage pumping station at Del Mar, and Lakeview to double present capacity of central pumping station. Estimated cost $300,000.

## Equipment Wanted

**Boiler and Pump—San Francisco, Calif.**—Eng-Skell Co., 208 Mission St., is receiving bids for a 60 hp. boiler and deep well turbine pump for factory.

**Boiler, Stoker, Engine, etc.—St. Louis, Mo.**—Bd. of Education, 911 Locust St., will receive bids until Sept. 3 for boiler, stoker, uniflow engine, smoke stack, etc. for power plant.

**Engines—Washington, D. C.**—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Sept. 5, for two Diesel engines, 350 hp., direct, vertical, reversing with double and shaft extension for ferry-boat drive, and with complete set of tools for each engine.

**Engines and Electrical Equipment — Goshen, Ind.** — Bd. of Public Works, will receive bids until Aug. 27, for Diesel engines, electrical equipment and accessories for proposed electric generating plant.

**Generator Set — Indianapolis, Ind.** — Bd. of Trustees, Central State Hospital, will receive bids until Aug. 29, for a turbo generator set.

**Generators, Boilers, Pumping Units, etc.—Mellville, R. I.**—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans removing and reinstalling three generator sets and furnishing four boilers with set oil pumping units, etc.

**Mechanical Equipment — Carroll, Ia.** — City, W. A. Arts, Clk., will receive bids until Aug. 20, for mechanical equipment for proposed sewage treatment plant.

**Meters—Jacksonville, Fla.**—City Commission, St. Elmo W. Acosta, Chn., will receive bids until Sept. 17, for 1,000 more or less induction recording watt hour meters, both single ph. and multiphase for 110 and 330 v., 60 cycle, for electric sub-station.

**Power House Equipment—Woodbine, N. J.**—Dept. of Institutions and Agencies, State Office Bldg., Trenton, will receive bids until Aug. 26, for furnishing and installing power house equipment, etc. at State Colony for Feeble Minded Males, here. Estimated cost $25,000.

**Pump—Brookings, S. D.**—City will receive bids until Aug. 26, for sewage pump or ejector for proposed sewage treatment work.

**Pumping Equipment — Texline, Tex.** — West Texas Utilities Co., Abilene, plans the installation of additional pumping equipment, etc. for recently acquired light and waterworks plant, here.

**Pumps—Geary, Okla.**—City, T. J. Stephenson, Clk., will receive bids until Sept. 4 for two 300 g.p.m. motor driven pumps, etc. for proposed waterworks improvements. Estimated cost $40,000.

**Pumps—Fond du Lac, Wis.**—City will receive bids until Aug. 27 for 3 m.g.p.d. motor driven centrifugal pumps, one 1400 g.p.m. deep well pump, etc. for proposed waterworks system. Estimated cost $55,000.

**Pumps—Granite Pass, Ore.**—City will receive bids about Sept. 7 for new pumps, etc. for proposed waterworks system. Estimated cost $400,000.

**Pumps, Motors, etc.—Milwaukee, Wis.**—Sewerage Commission, plans to purchase three 15 m.g.p.d. return sludge pumps, motors, etc. Estimated cost $45,000.

## Industrial Projects

**Calif., Long Beach**—Ford Motor Car Co., 3674 Schaefer Rd., Dearborn, Mich., awarded contract for a 1 story, 86 x 480 ft. pressed steel plant here to Clinton Construction Co., Spring-Arcade Bldg., Los Angeles. $350,000.

**Calif., Los Angeles**—Consolidated Steel Corp., 1200 North Main St., plans the construction of a plant to house manufacturing units for structural steel operations and production of pontoon decks and bolted tanks at Saluson and Eastern Aves., Private plans.

**Idaho, Wardner** — John, George and Frank Bingham, plan the construction of a 150 ton concentration plant. Engineer not announced.

**Ind., South Bend** — Roach-Appleton Co., awarded contract for the construction of a 1 story, 200 x 250 ft. factory for the manufacture of electrical products, to R. Sollitt & Sons, 518 East Sample St. Estimated cost $100,000.

**Mass., Cambridge (Boston P. O.)** — F. W. Webster Co., 340 Congress St., Boston, awarded contract for a 4 story, 100 x 120 ft. factory for the manufacture of typewriter supplies at Hayward and Wadsworth Sts., to Turner Construction Co., 178 Tremont St., Boston. Estimated cost $250,000.

**Mass., East Fitchburg**—Simonds Saw & Steel Co., G. K. Simonds, Gen. Mgr., is having plans prepared for the construction of a 360 x 550 ft. factory on Railroad St. Estimated cost $1,000,000. Private plans.

**Mass., Everett**—Merrimac Chemical Co., Chemical Lane, will soon award contract for a 2 story, 50 x 172 ft. chemical bottling plant. Estimated cost $60,000. Private plans.

**Mich., Detroit** — Detroit Gray Iron Foundry, 6403 Wight St., plans the construction of a 2 story, 115 x 170 ft. addition to foundry on Meldrum Ave. Estimated cost $50,000. Mildner & Eisen, 924 Hammond Bldg., are architects. Electric motors and iron foundry equipment will be required.

**O., Akron** — Telling Belle Vernon Co., J. H. Schindler, Pres., 3825 Cedar Ave., Cleveland, will soon award contract for a 3 and 4 story, 102 x 122 ft. ice cream plant at Cedar and Water Sts. Estimated cost $250,000. Braziel & Anderson, 309 Fourth Ave Ave., Pittsburgh, Pa., are architects.

**O., Youngstown**—Anson Aero Mfg. Co., plans the construction of a 1 story factory for the manufacture of airplanes on Meriden Rd. Estimated cost $100,000.

**Pa., Philadelphia**—D. Berger, 129 South 9th St., awarded contract for a 2 story, 58 x 155 ft. hosiery mill at H. and Sycommer Sts. to G. Kessler Co., 1733 Marvine St.

**Tex., Galveston**—E. J. Hoffman Mfg. & Development Co., is receiving bids for the construction of 1 story, 50 x 200 ft. plant for the manufacture of automobile headlights, air pumps, airplanes accessories, etc. Machinery and equipment including 1 to 5 hp. motors, etc. will be required.

**Wis., Beaver Dam**—Bear Brand Hosiery Co., awarded contract for a 4 story, 85 x 99 ft. factory to Immel Construction Co., Fond du Lac.